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Electricity

AS AN AREA OF

INDUSTRIAL ARTS INSTRUCTION IN PENNSYLVANIA PUBLIC SCHOOLS

SUBJECT AREAS

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Ceramics	Metal Forming	Sheet Metal
Electricity	Metal Machining	Textiles
Graphic Arts	Planning	Woodworking

BULLETIN 331-C • 1954

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF PUBLIC INSTRUCTION • Harrisburg

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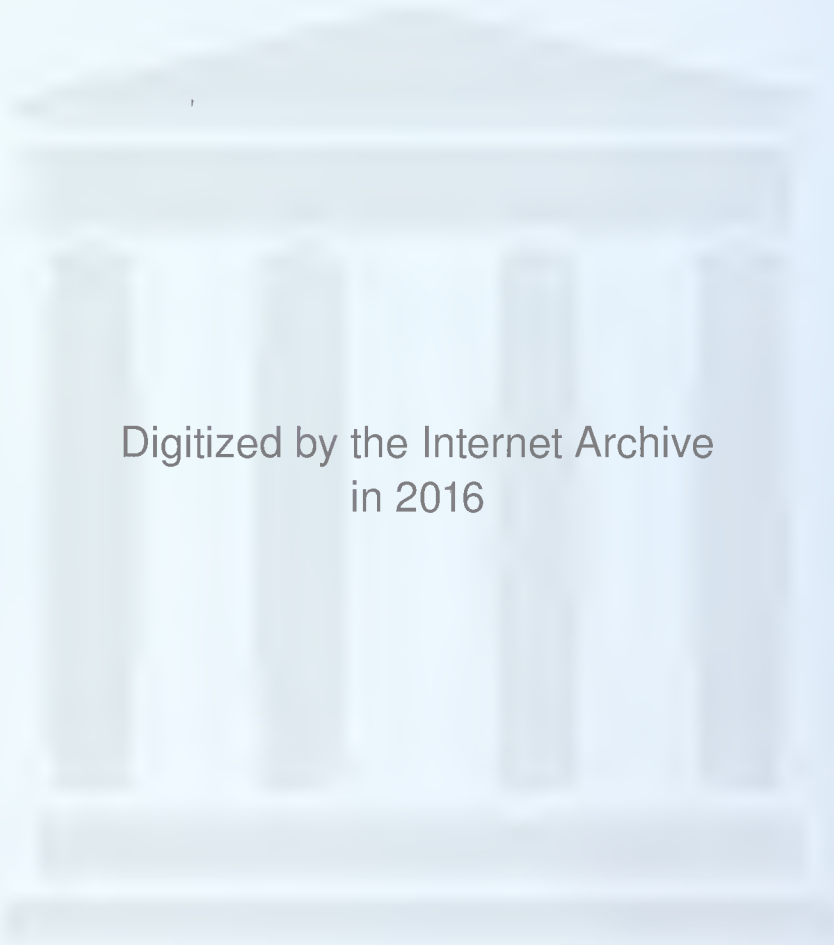
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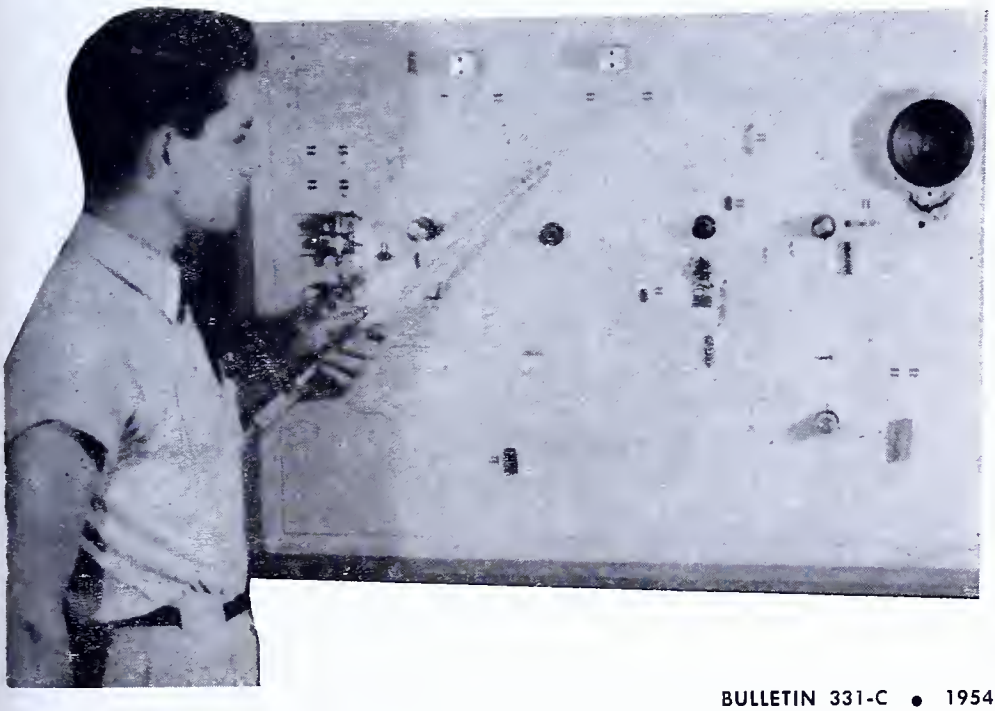

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COMMONWEALTH OF PENNSYLVANIA
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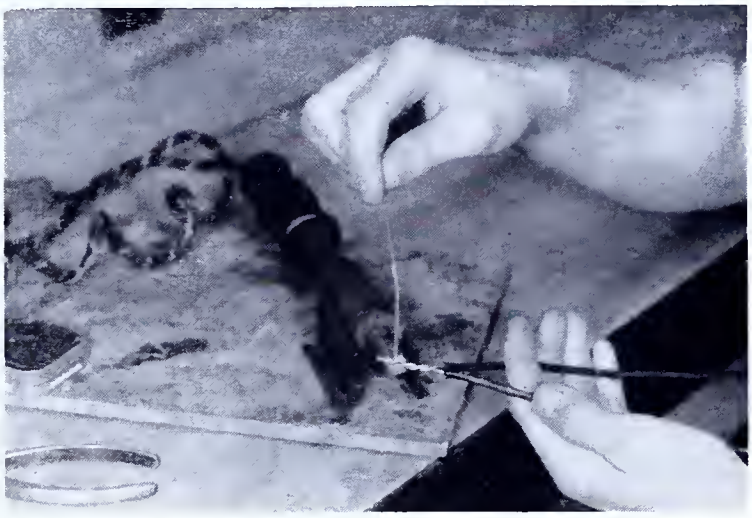
Foreword



ELECTRICITY AS AN AREA OF INDUSTRIAL ARTS INSTRUCTION is one of a series of bulletins prepared to stimulate specific areas of instruction in the broad field of Industrial Arts Education. It is a supplement to *Industrial Arts in Pennsylvania,* Bulletin 331, published in September of 1951 by the Department of Public Instruction. Need for this bulletin has been manifested in requests from Pennsylvania educators for information and assistance.

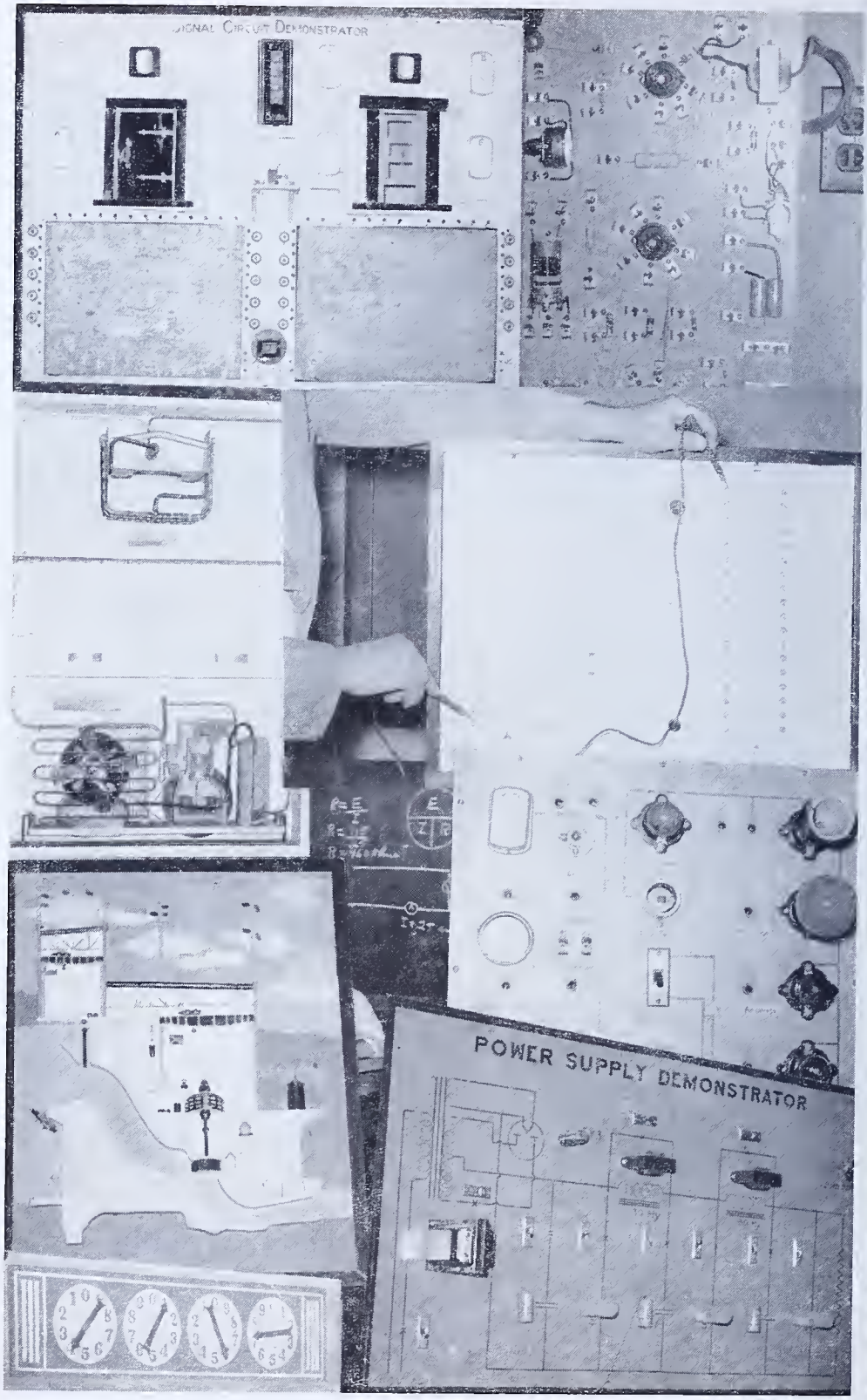
Electricity was prepared by Thomas Pryde, Area Coordinator of Trade and Industrial Education, under the supervision of Robert T. Stoner, Director of the Bureau of Adult, Vocational and Practical Arts Education. Preliminary work on manuscript and layout planning were done by R. Randolph Karch, Adviser, Trade and Industrial Education.

Appreciation is extended to Merrill G. Campbell, member of the Industrial Arts faculty, State Teachers College, California, Pennsylvania, for his constructive criticism and suggestions in the preparation of this bulletin, and to the Butler and Pittsburgh school districts and to the California State Teachers College for their cooperation in providing photographs and allowing photographs to be taken in their shops.

This bulletin has been edited by Rachel S. Turner, Editor for the Department of Public Instruction.

Francis B. Haas

June 1954 *Superintendent of Public Instruction*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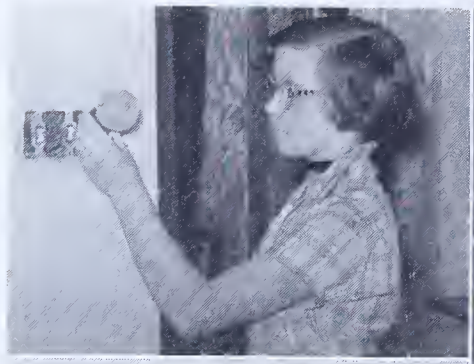


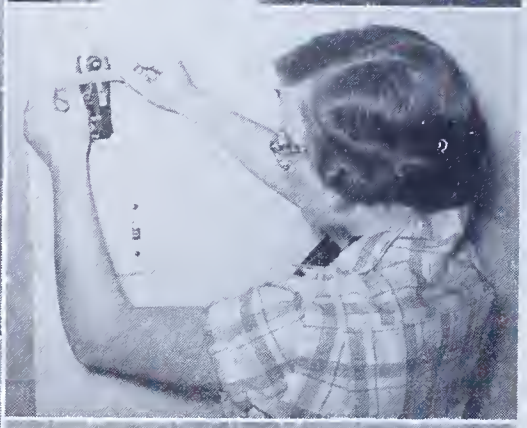
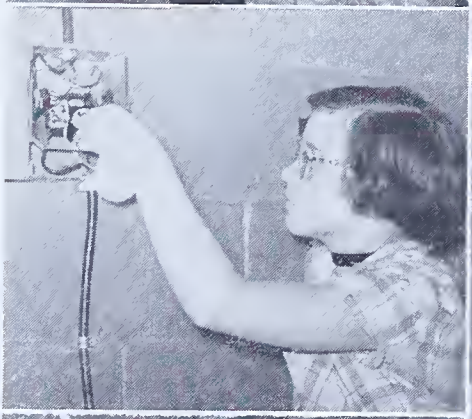

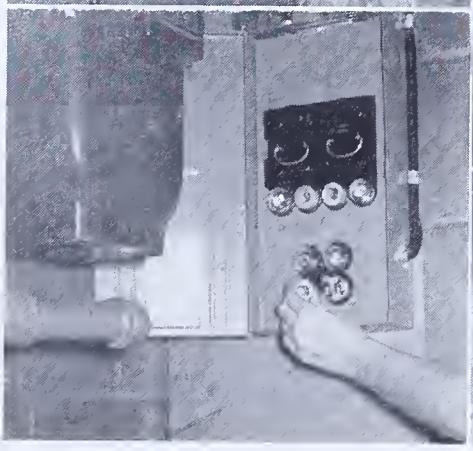


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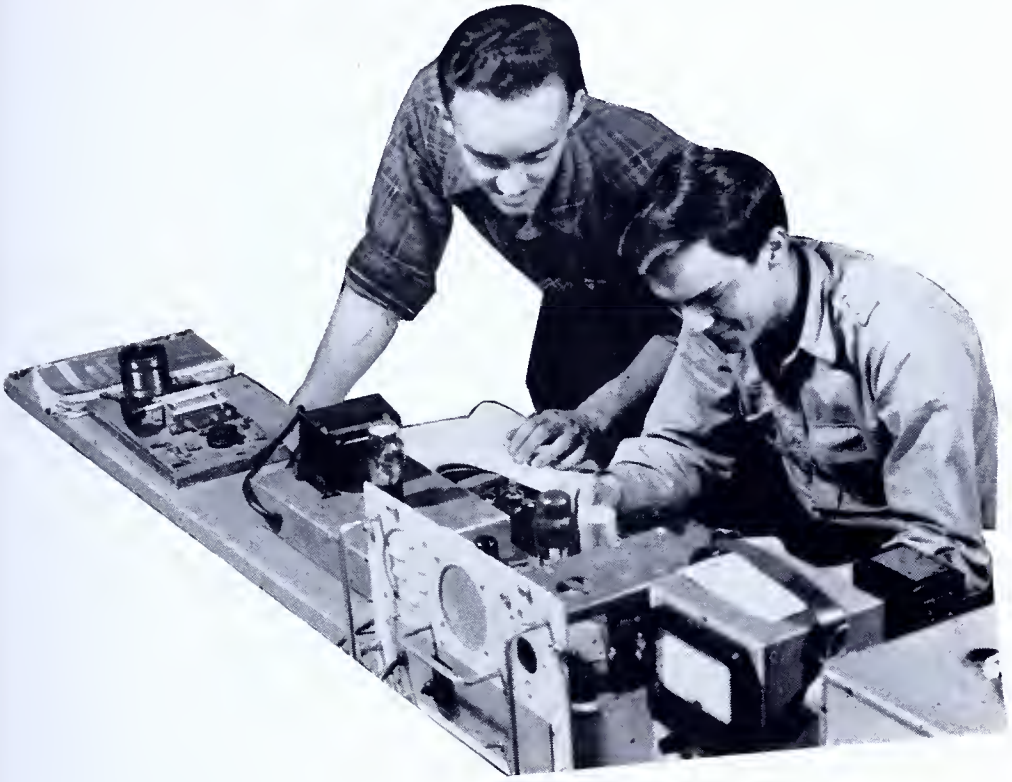


ELECTRICITY touches the lives of all of us. Today in our industrial democracy the applications of electricity have become a necessity. Since the use of electricity is so common an experience to all of us, its study deserves a prominent place in the general education of secondary school pupils.

Attention is directed in this bulletin to practical laboratory instruction in electricity, one of the fields within the broad area of Industrial Arts Education. Exploratory experiences are provided in the use of tools, equipment, materials, and processes common to practically all home and industrial activities. Appreciations and understandings concerning repairing, reconditioning, adjusting, and maintaining the many electrical applications which are the normal concern of us all are taught.

Because of the differences in educational concepts, in backgrounds of administrator and teacher, in variations in the time pupils spend on the activity, in amount of funds available for equipment and supplies, as well as in other factors, no attempt is made in this bulletin to set up a common course of study applicable to all situa-

tions, or to tell the teacher what to teach, how to teach, or what equipment he should have in his shop.

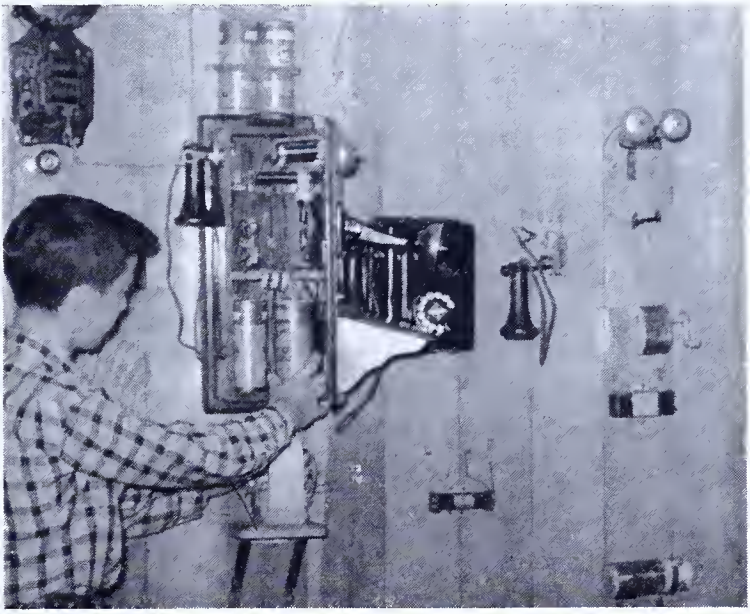
This bulletin does list, in the "Things to Do" and "Things to Know" sections on pages 5 to 29, course content which may be selected by the teacher. These learning units also help to determine particular aims and objectives, amount of time available to pupils in the Electrical Laboratory area, and the necessary equipment.

Suggestions to guide the administrator are made on the organization of instruction, instructional material, tools and devices, possible projects, sample job assignments, and the use of records and forms, including samples of the information sheet and the operation sheet. Included for further guidance are an annotated bibliography of readily available instructional materials and visual aids, a suggested inventory of equipment and supplies with their approximate cost, a plan for the electricity activities center, and other information related to establishing or enriching the Electrical Laboratory unit of a comprehensive general shop, or a unit (one activity) shop.

For further information pertaining to Industrial Arts in general the reader is referred to Bulletin 331, *Industrial Arts in Pennsylvania,* published by the Department of Public Instruction, September, 1951.

1 Electricity

AS A SCHOOL SUBJECT



THE UNDERLYING PHILOSOPHY of the area of electricity as presented in this bulletin is similar to the basic philosophy of all Industrial Arts Education in that it provides experiences in a variety of phases of the subject field using many different tools, materials and processes. It is an area of Industrial Arts Education providing information and practical experiences which will enable the pupil to understand and use electricity and the electrical equipment basic to daily living. Attention is given to instruction which will also enable the pupil to do better those things pertaining to electricity which he will do anyway, and will provide opportunity for him to extend this knowledge in one or more special fields. The accomplishment of the objectives set forth for the electricity area should make the pupil a more intelligent consumer; a safer workman, more competent in selecting his vocation; and a better citizen through greater understanding and appreciation of the work done by others to serve his daily needs.

The field of electricity is well suited to be one of the several areas of Industrial Arts Instruction in a comprehensive general shop offering at least four separate activities. Electricity is also a field which

can be taught as a unit shop activity with stress on one or more of its several branches. It touches the general curriculum at many points. Several of the electrical activities lend themselves well to integration in units of communication and transportation.

The school administrator and the Industrial Arts teacher will find a widespread pupil interest in the field of electricity if it is taught with the up-to-date equipment now used in the home and in industry.

Objectives of The Electrical Laboratory

The Electrical Laboratory should assist in the attainment of the broad general objectives of Industrial Arts Education as outlined on page 19 of Bulletin 331, *Industrial Arts in Pennsylvania.* Objectives are formulated in terms of the goals desired. They provide a basis for the choice of subject matter and serve as a means for the evaluation of pupil progress. The determination of objectives is the starting point in the development of this area of instruction; therefore the specific objectives of this activity should include:

1. Encouraging an interest in, and an understanding of, the place of electricity in industry and in the home
2. Developing the ability to select various electrical products and appliances wisely and to use and care for them properly
3. Developing the ability to recognize and appreciate good workmanship, construction, and design in electrical appliances, equipment, and installations
4. Emphasizing the importance of safe habits in using and working with electricity and electrical equipment
5. Creating a wholesome interest in hobby or leisure-time activities associated with electricity in its many and varied uses
6. Teaching the pupil to understand wiring and connection diagrams supplied with common electrical equipment in everyday use
7. Developing the habit of orderly procedure in conceiving, planning, checking, and executing electrical installation and projects
8. Providing exploratory and try-out experiences intended to open up the wide range of occupational opportunities in the general field of electricity

9. Providing a practical working knowledge of everyday electrical applications
10. Providing limited training in occupational skills commensurate with the abilities and interests of the pupils

Organization and Grade Level

The instructional program outlined in this bulletin represents a broad coverage of many applications of electricity. The teacher may determine what units to teach his pupils in elementary or advanced classes. For example, radio may be presented to junior high school classes by means of a crystal or razor-blade receiver, and to the senior high school classes through a multi-tube receiver. The content is designed for use at all levels of education. The elementary phases may be offered in the junior high school program, and the specialized phases may be offered in the senior high school.

This approach offers much flexibility because the sections of the bulletin are not interdependent, except for Part 1, Unit A, "Getting Acquainted with Electricity," and Part 1, Unit B, "Making Electrical Pathways," which should be taught concurrently. The school administrator or teacher is free to select those units which best fit his program or his scheduling needs. He may make one selection to cover a semester of work in a comprehensive general shop at the junior high school level, or another selection to cover three years of work in a unit shop at the senior high school level.

Instruction classes in electricity may include girls. The home application of this field, as well as the need for consumer knowledge, appeals to many girls. The practical work of repairing home appliances may be subordinated to the teaching of consumer values, safe practices, and safety devices in the home. Elementary diagnosis of electrical failure of home appliances should be stressed, so that simple faults may be found and repaired quickly, *and serious faults referred to a competent repairman.*

Areas of instruction have been selected and grouped which will best develop an understanding of the electrical field from its basic and common applications to the more complex uses which involve a knowledge of wide areas of the subject. The instructor is free to select the method of presentation best suited to any of the several topics ranging from class demonstration to individual instruction.

Emphasis is placed upon "knowing" rather than "doing", because the basic hand skills in electricity are comparatively few. An amazing amount of electrical construction and repair can be accomplished with a knife, a screwdriver, and a pair of pliers by one who has a good knowledge and understanding of the electrical principles which apply to the job.

Tools, Materials, and Processes

Electricity as an activity develops the philosophy of Industrial Arts education by providing opportunity for experience with tools, operations, materials, and processes common to many fields. The materials used in electrical wiring, power applications, electrical appliances, and in electronics cover nearly the entire range of the materials of industry.

The pupil perhaps encounters wire as a material of industry for the first time in this area of instruction. He will work with hand tools and basic machine tools of several trades, because he will find it necessary to work indiscriminately in wood, ferrous and nonferrous metals, masonry, plastics, and other synthetic materials.

Occupations

Few fields offer as many varied and related occupations as the field of electricity. Electricity is the basic energy source of literally thousands of various applications ranging from the high-powered energy of the transmission lines to the tiny impulses of the microphone or electric eye. The second edition of the *Dictionary of Occupational Titles* lists over 300 different job titles under the heading of "Electric" or "Electrician". These headings do not include jobs listed under such related occupational headings as "Radio," "Telephone," and "Television."

It is apparent that an important function of Industrial Arts education is to provide exploratory experiences, vocational information, and an understanding of vocational opportunities at the time when pupils are considering vocational choices. Acquiring a comprehensive view of occupational choices is a difficult task in our diversified and specialized industrial civilization. Young people, faced with the problem of choosing a vocation, first consider those fields of work with which they have had contact or about which they have had information. The electrical activity can be important in widening the pupil's knowledge of vocational opportunities.

2 Learning Units

THINGS TO *Do* AND THINGS TO *Know*

THE BASIS FOR THE SELECTION of subject matter for an Industrial Arts activity is an analysis of the processes of industry. The analysis provides a list of the manipulative or practical "doing" units as well as informational content. Final selection of subject matter is based on those experiences which are representative of and fundamental to the activity, and which contribute to the objectives of the course. The final result is a list of learning units which represent the things a pupil should be able to *do* and the things he should *know*.

The following analysis of the Electrical Laboratory activity is based on the types of repair, maintenance, and improvement jobs commonly

found in the home and in industry. These activities are classified under the following four general divisions:

Part I. Understanding electricity
Part II. Distributing electricity in the home
Part III. Electricity at work in the home
Part IV. Electricity at work in industry

PART I. UNDERSTANDING ELECTRICITY

Unit A. Getting Acquainted with Electricity

Things to Do	Things to Know
1. Inspect and make a sketch of a cutaway dry cell	a. How the dry cell produces electricity b. How to revive a weak dry cell c. Uses for dry cells
2. Measure the voltage and current output of a dry cell	a. Meaning of voltage b. Meaning of current c. How to use a voltmeter d. How to use an ammeter
3. Construct a wet cell	a. How a wet cell produces electricity b. Kinds of wet primary cells c. Uses for wet cells
4. Produce static electricity	a. Nature of static electricity b. Ways in which static electricity occurs in nature c. Effects of static electricity d. Comparison of static with current electricity e. Ways to eliminate harmful static electricity
5. Measure large currents (20-30 amp.) in a direct current circuit	a. Heating effect of electrical current b. Current-carrying capacity of conductors c. How to select the correct meters to measure current d. Use of fuses and other protective devices

Things to Do	Things to Know
6. Measure voltages in a circuit (6-110/220 volts)	a. Differences in the effect of high voltage and heavy current on conductors b. How to select the correct meters to measure voltage c. Safety precautions needed for higher voltages d. Differences in insulation requirements for high voltages and high currents
7. Connect different resistances to a source of direct current and measure the voltage and current values	a. Nature of resistance b. Effects of resistance c. Relationship of current, voltage, and resistance d. How to calculate resistance e. Effects of changes in resistance on current and voltage
8. Examine a cutaway storage battery and list the major parts	a. Action of a storage battery b. Current and voltage capacity of the storage battery c. How a storage battery compares with a primary battery d. How storage batteries are rated e. Logical uses for storage batteries f. Use of the storage battery in an automobile g. Proper care and maintenance of a storage battery
9. Make an electromagnet	a. What is meant by an electromagnet b. How to wind an electromagnet c. Characteristics of electromagnets d. Uses for electromagnets e. Differences between an air core and an iron core

Things to Do	Things to Know
10. Test various metals for magnetism	a. Characteristics of magnetism b. Magnetic properties of metals
11. Make and use a compass	a. Earth's magnetic field b. Characteristics of a permanent magnet c. Characteristics of an electromagnet
12. Make a bar magnet and mark the poles	a. How to magnetize a bar b. How to test for polarity c. Magnetic properties of hard and soft steel d. How to demagnetize e. How to shield a magnet
13. Trace magnetic paths using iron filings and compass (bar magnet, horseshoe magnet, coil of wire, and straight wire)	a. What is meant by a magnetic field b. Magnetic field surrounding a conductor c. Uses of magnetic fields d. Characteristics of magnetic fields made by alternating and direct current
14. Clean, fill, and connect a storage battery to a battery charger or other rectifier	a. Polarity b. Use of a battery hydrometer and the meaning of "specific gravity" c. Definition of electrolyte, how high it should be kept, what is used to keep it there, and when to fill it d. Value of "battery reconditioning agents" e. Devices used to charge a storage battery f. Safety precautions in handling and charging storage batteries g. Advantages and disadvantages of high-speed chargers

Things to Do	Things to Know
15. Test an electromagnet with a compass for polarity when carrying direct current and when carrying alternating current	a. How to test for polarity b. Differences between a direct current and an alternating current magnetic field
16. Examine and draw a sketch of a doorbell transformer	a. Principle of a transformer b. Meaning of primary and secondary coils c. What is meant by "transformer ratio" d. Voltage relationships in a transformer e. Current relationships in a transformer f. Safety precautions when using a transformer g. How to test a transformer h. How to connect a transformer
17. Examine and sketch the transformer of a toy train	a. Differences between a toy train transformer and a bell transformer b. Methods of securing variable voltage from a transformer c. Effects of overloading circuits d. What makes a toy train go fast and slow e. Effects of putting more cars on the toy train
18. Examine and sketch a buzzer, doorbell, or door chimes	a. Kind of magnet used to operate annunciators b. Principles of operation of annunciators c. How to locate trouble in annunciators d. How to repair annunciators

Things to Do	Things to Know
19. Connect a bell and push button to a doorbell transformer[1]	a. How to read a simple diagram b. How to connect bells, buzzers, and chimes c. How to ring a doorbell, using a button d. How to locate trouble when a doorbell will not ring

[1] It is recommended that bell wiring, as such, be severely limited so that a variety of work may be done and the interest of the pupil is not stifled.

Unit B. Making Electrical Pathways

Things to Do	Things to Know
1. Terminate electrical pathways on (1) plug caps (2) lamp sockets (3) sockets (4) appliance fittings (5) cube taps (6) tangs (7) lugs	a. How to tie an Underwriters' knot b. How to make a wire loop c. How to fasten a wire under a screw terminal d. Kinds and uses of terminal lugs e. Code[1] requirements for switch and outlet connections f. Code[1] requirements for extension cords g. Code[1] requirements for appliance cords h. Types and sizes of wires and insulation used in extension cords i. Types and sizes of wire and insulation used in appliance cords j. How to select extension, heater, and appliance cords k. How to obtain the best and longest service from cords
2. Provide several electrical pathways	a. How to extend wires by the use of sleeves and the Western Union splice b. How to make branches with tee-tap, rat-tail, and fixture splice c. Wire sizes d. Types of wire coverings e. How to remove insulation f. How to replace insulation g. Causes of damage to wire h. Effects of faulty insulation i. Effects of faulty connections
3. Use solderless connectors	a. Kinds of solderless connectors b. Types of joints on which solderless connectors may be used c. Code requirements for the use of solderless connectors

[1] "Code" refers to National Electrical Code, standard of the National Board of Fire Underwriters.

Things to Do	Things to Know
4. Solder electrical connections	a. How to light a blow torch b. Care of blow torches c. How to tin a soldering iron d. Kinds of flux and their uses e. Kinds of solders and their uses f. Use and care of electric soldering irons and soldering guns g. Safety precautions in the use of torches and open flames h. Code[1] requirements for soldered joints

Unit C. Electrical Pathfinding[2]

Things to Do	Things to Know
1. Make one light burn brightly	a. How to read a simple diagram b. How to make pigtails c. How to connect one switch and one light in series d. How to use insulated fasteners
2. Make two lights burn brightly	a. How to connect one switch with two lights in parallel
3. Make many lights burn brightly	a. How to connect one switch and several lights in parallel b. Characteristics of a parallel circuit
4. Make two lights burn dimly	a. How to connect one switch and two lights in series b. Effect of having the lights in series with each other
5. Connect a string of Christmas lights	a. Characteristics of a series circuit b. How to determine the correct number of sockets and lights to use in connecting a string of lights to house lines

[1] "Code" refers to National Electrical Code, standard of the National Board of Fire Underwriters.

[2] Miniature lamps and knife switches are used on low voltage for this unit.

Things to Do	Things to Know
6. Connect three switches so that each makes three lights burn brightly	a. How to connect switches and lights in a parallel circuit
7. Add one light to the above group which burns continuously	a. How a convenience outlet is connected in a circuit b. How to determine the load on a circuit c. Current-carrying capacity of wires d. Use of a wire table e. Effect of too many lights or appliances on the wires f. Materials used for conductors and insulators g. How to trace the paths of electricity h. Effect of a broken wire i. What happens when bare wires touch

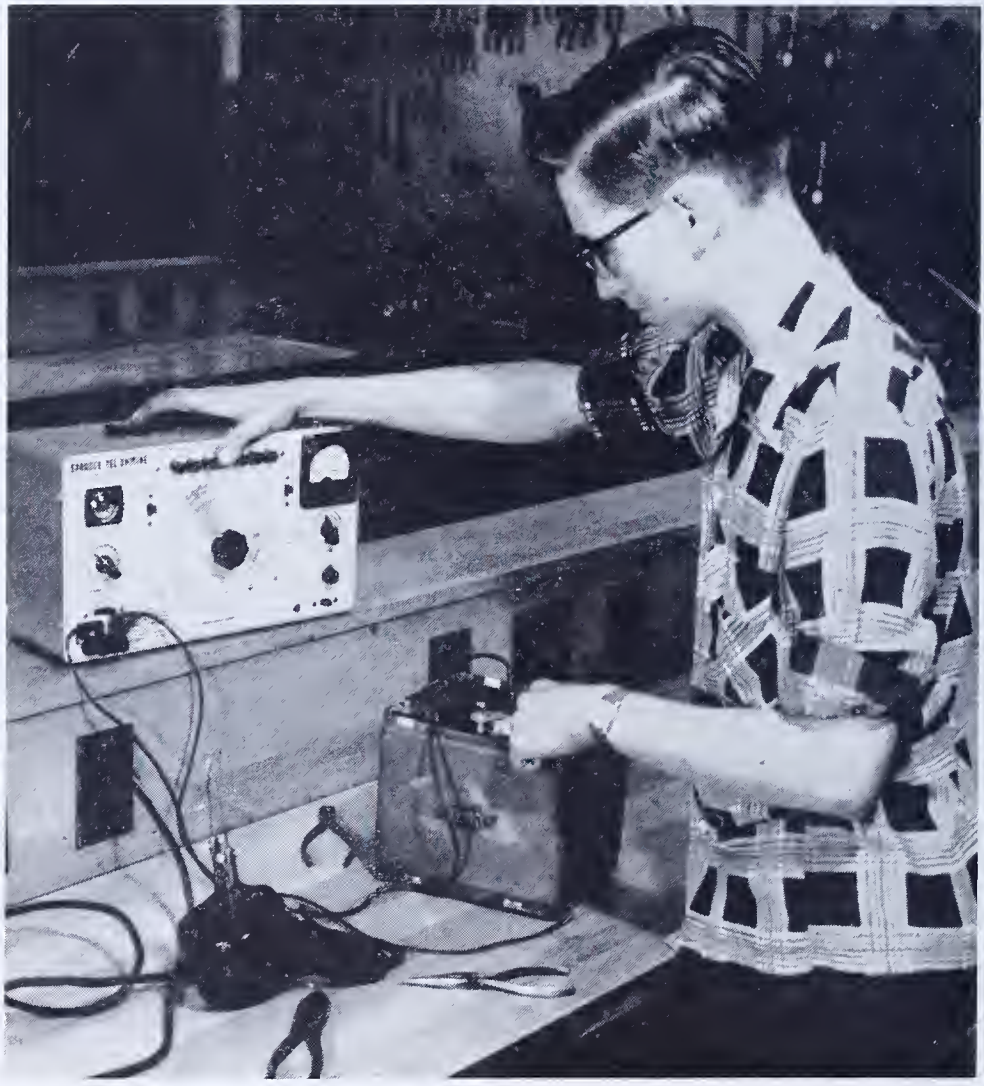
PART II. DISTRIBUTING ELECTRICITY IN THE HOME

Unit A. Home-wiring Repairs

Things to Do	Things to Know
1. Trace and sketch how electricity enters the home	a. How to disconnect house lines from the supply line b. Entrance needs for stoves and dryers c. What constitutes a good electrical service entrance d. Code requirements for electrical service entrances e. Advantages of two-wire and three-wire service entrances
2. Test fuses and other devices used to protect the wiring and the home	a. Purpose of fuses and overload protective devices b. How to test for a blown fuse c. How to find the cause of blown fuses d. When to call an electrician e. Safety precautions when handling and using fuses and switches f. What constitutes a circuit in a home g. Capacities of home circuits h. Selection of correct fuse capacities
3. Replace a wall switch controlling one light or one group of lights	a. Kinds of switches used in the home b. Assembly of switch box, switch, and cover plate c. How to fasten wires under a terminal d. Code requirements for switch installations e. How to turn off electricity when replacing a switch

Things to Do	Things to Know
4. Replace a convenience outlet	a. Kinds of convenience outlets b. Safe practices in using convenience outlets c. How to connect a convenience outlet d. Assembly of convenience outlet boxes, outlets, and cover plates e. Proper number and location of home outlets
5. Replace an incandescent light fixture	a. Methods of assembling light fixtures b. Methods of mounting light fixtures c. Kinds of fixture wire d. Direct and indirect light fixtures e. Characteristics of a good light fixture f. Kinds of fixtures suitable for the home g. Kinds of light bulbs
6. Rewire a floor or table lamp	a. How to fasten a wire in a socket b. Methods of insulating wires passing through a lamp base or column c. Dangers from worn cords d. How sockets are fastened to various supports e. Safety precautions in lamp wiring f. Wiring of multiple-watt lamps
7. Replace one of a pair of switches controlling one light	a. Fundamental circuit for using three-way switches b. How to locate the shunt bar in a switch c. Other types of multiple light controls d. Possible uses of multiple controls in a home

Things to Do	Things to Know
8. Replace a fluorescent lamp, starter, and fixture	a. Principle of the fluorescent lamp b. Purpose of the fluorescent lamp starter c. Construction of a fluorescent lamp d. Advantages and disadvantages of fluorescent lighting e. Place of fluorescent lighting in the home f. Kinds of fluorescent fixtures available



Unit B. Home-wiring Installations

Things to Do	Things to Know
1. Install a branch circuit using armored cable	a. How the armor is removed b. Code requirements for armored cable installations c. Methods of installing armored cable in new construction d. Methods of installing armored cable in old construction e. Use of anti-short bushings f. Use of various clamps and fastening devices g. Current limitations for branch circuits h. Advantages and disadvantages of armored cable i. How to recognize good electrical installations
2. Install a branch circuit using nonmetallic-sheathed cable	a. How to remove insulating sheathing b. Code requirements for nonmetallic-sheathed cable installations c. Methods of installing nonmetallic-sheathed cable in new construction d. Methods of installing nonmetallic-sheathed cable in old construction e. Use of clamping and fastening devices for cables f. Current limitations for branch circuits g. Advantages and disadvantages of nonmetallic-sheathed cable
3. Install a branch circuit using rigid conduit	a. How to cut and thread rigid conduit b. How to bend rigid conduit

Things to Do	Things to Know
3. Install a branch circuit using rigid conduit *(continued)*	c. How to measure a rigid conduit installation d. Code requirements for a rigid conduit installation e. Advantages and disadvantages of a rigid conduit installation f. How to install rigid conduit in new construction g. Use of rigid conduit for outdoor installations h. Methods of fastening rigid conduit to various construction materials
4. Install a branch circuit using metallic raceways	a. Differences between *open* and *concealed* wiring b. Dangers of using extension cords in place of wiring c. Code requirements for open wiring d. How to cut metallic raceways e. How to bend and fit metallic raceways f. How to install metallic raceways g. Use of *plug-strips* h. Advantages and disadvantages of metallic raceways

PART III. ELECTRICITY AT WORK IN THE HOME

Unit A. Understanding Electrical Power

Things to Do	Things to Know
1. Examine a home-type kilowatt-hour meter and read the dial	a. How to read a kilowatt-hour meter b. How to compute cost of electricity used c. Purpose of the kilowatt-hour meter d. Principle of operation of a kilowatt-hour meter e. Method of measuring electrical power
2. Measure electrical power by the voltmeter-ammeter method	a. How to connect instruments to measure power b. Understand the formula for calculating electrical power c. Definition of watts and kilowatts
3. Measure electrical power by using a wattmeter	a. How to connect a wattmeter b. Differences between a wattmeter and a kilowatt-hour meter
4. Measure electrical power in an alternating current circuit by the voltmeter-ammeter method and by a wattmeter *(optional)*	a. Meaning of power in an alternating current circuit b. Meaning of *KVA* c. Meaning of *power factor* d. Kinds of appliances that lower the power factor
5. Measure the power required by heat-producing appliances (electric iron, toaster, waffle iron, lamp, heater, etc.)	a. Power consumption needs of heat-producing appliances b. How to read name plate on an electrical appliance c. Load capacity of home-wiring circuits d. Number of appliances which may be used on one circuit e. Proper wiring of appliance circuits f. Code requirements for appliance circuits

Things to Do	Things to Know
6. Measure the power required by motor-driven appliances (electric mixer, vacuum cleaner, washing machine, etc.)	a. Power consumption needs of motor-driven appliances b. How to read the name plate on a motor-driven appliance c. Effect of the starting current on the branch circuit load d. Comparison of the power needs of home appliances e. Necessity of, and methods for, grounding electrical appliances

Unit B. Heat-Producing Electrical Appliances

Things to Do	Things to Know
1. Test heat-producing electrical appliances (Irons, toasters, ranges, roasters, broilers, water heaters, space heaters, waffle irons)	a. How to test for grounds and for open and short circuits in heat-producing appliances b. How to locate and isolate an electrical fault c. Types of common electrical faults d. Faults which should be repaired only by a competent repairman e. Characteristics of a well-constructed heat-producing appliance
2. Repair heat-producing electrical appliances	a. How heat is controlled b. Danger points in each appliance and how to prevent damage c. Practices which shorten the life of an appliance d. How the appliance is constructed e. How to disassemble and assemble appliances f. How to repair and replace heating elements g. How to repair and replace thermostats and other control devices h. How to repair and replace extension cords i. Characteristics of good appliances j. Proper care and maintenance of appliances

Unit C. Motor-Driven Electrical Appliances

Things to Do	Things to Know
1. Examine, draw wiring diagrams, disassemble and assemble — series, split-phase, capacitor, repulsion-induction, and induction motors	a. Operating principles of each type of motor b. Wiring circuits of each type of motor c. Distinction between AC and DC motors d. Purpose of a commutator e. Construction of an armature f. Care and maintenance of each type of motor g. Electrical characteristics of each type of motor h. How to select motors
2. Clean, adjust, test, and repair each type of motor	a. How to disassemble and assemble motors b. How to test the motor for grounds, and for open and short circuits c. Care and maintenance of brushes and commutators d. How to repair commutators e. How to clean and dress a commutator and undercut the mica f. Proper clearance between rotor and pole pieces g. How to replace bearings h. Construction, operation, and repair of starting switches i. Proper lubrication of motors j. How motor windings are insulated k. How to connect new cords l. How to reverse motor rotation

Things to Do	Things to Know
3. Examine and sketch the essential working parts of motor-driven electrical appliances — vacuum cleaners, mixers, washing machines, irons, clocks, lawn mowers, compressors, fans, floor polishers, sewing machines, pumps, and clothes dryers	a. Characteristics of a good appliance b. Types of appliances c. Proper care and maintenance of appliances d. Safe operating practice in working with appliances e. How appliances are constructed f. Practices which shorten the life of an appliance
4. Examine, test, and repair motor-driven appliances provided by the school or brought to school by pupils	a. How to disassemble and assemble appliances b. How to test appliances for faults c. How to repair or replace worn and broken appliance parts

Unit D. Electronic Devices

Things to Do	Things to Know
1. Draw the circuit for and construct a simple radio receiver	a. How to read radio circuit diagrams b. Theory of fundamental electronic circuits c. Theory of radio tubes d. Radio identification codes e. How to read code signals f. Characteristics of good radio sets g. How to judge the quality of a radio set
2. Test and repair radio receivers belonging to the school and to pupils	a. How to use radio test instruments b. How to diagnose radio troubles c. How to disassemble and assemble radio sets d. How to test radio sets for faults

Things to Do	Things to Know
3. Build a radio receiver (type and size to depend on local conditions)	a. Principles and construction of radio receivers
4. Build an amateur radio station *(optional)*	a. Principles and construction of short-wave radio transmitters b. Federal regulations governing transmitters c. Federal license requirements d. Principles and construction of short-wave receivers
5. Build a high-fidelity record player *(optional)*	a. Principles of acoustics b. Principles of sound reproduction c. Principles governing the recording of the human voice and musical instruments d. Principles and construction of high-fidelity amplifiers e. Principles and construction of high-fidelity speakers f. Principles of combining amplifiers and speakers
6. Install TV aerials *(optional)*	a. Principles of design for TV aerials b. How to adapt aerials to different channels and frequencies c. Kinds and characteristics of various boosters d. Kinds and characteristics of interference reducers e. How to install aerials in various situations (home, tower, apartment, community) f. Materials used in aerial construction g. Hazards inherent in aerials h. Safe practices to follow when installing aerials i. How to recognize a good aerial installation

Things to Do	Things to Know
7. Sketch the operating principles of the black and white television set	a. Fundamental principles and applications of radio circuits b. Fundamental principles of the cathode-ray tube c. Fundamental principles of the TV receiver d. Understand the principles of TV cameras and broadcasting equipment e. Characteristics of a good TV set f. How to judge the quality of a TV set
8. Adjust and service TV receivers	a. How to test TV receivers for faults b. How to adjust TV receivers for picture quality c. How to adjust receivers for sound quality d. How to operate TV test equipment
9. Build a TV receiving set *(optional)*	a. Principles and construction of TV receivers
10. Connect photo-electric cells (automatic door openers, burglar alarms)	a. Principles of operation and construction of photo-electric cells b. Use of relays c. Use of amplifiers d. Use of auxiliary equipment
11. Design and construct a home photo-electric cell circuit *(optional)*	a. Possibilities and limitations of photo-electric cells

PART IV. ELECTRICITY AT WORK IN INDUSTRY

Unit A. Telephone and Telegraph

Things to Do	Things to Know
1. Inspect and sketch the parts of a simple telephone set	a. Principles and construction of a telephone transmitter b. Principles and construction of a telephone receiver c. Principles and construction of a ringer d. Principles and construction of available auxiliary equipment e. Place of the telephone in modern living f. Organization of a central telephone office g. Understanding of the modern dial system h. How to read a telephone book i. Kinds of service available j. How a PBX board is operated
2. Install a two-telephone circuit with a ringer	a. How to read a telephone-wiring diagram b. Operation of each component part of a telephone circuit c. Proper electrical supply for each circuit d. Adjustment of telephone parts
3. Install a two- or three-station telegraph system	a. How to read a telegraph-wiring diagram b. Methods of installing simple telegraph equipment c. Learn the Morse Code (optional) d. Proper electrical supply for this equipment e. How to adjust telegraph sets

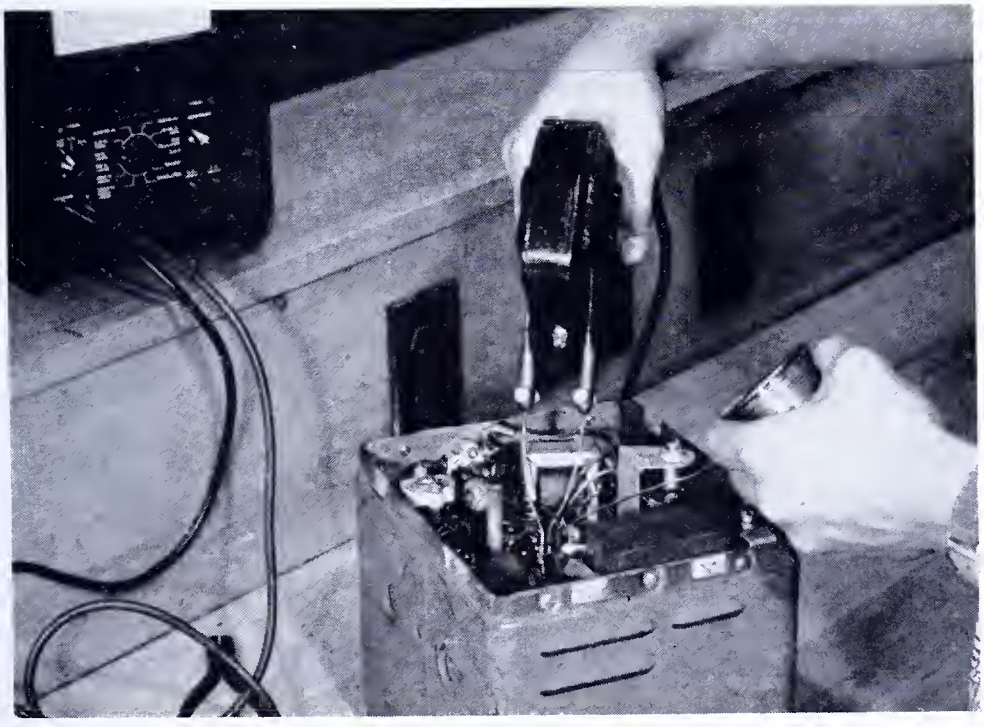
Things to Do	Things to Know
4. Inspect and sketch a telegraph key and sounder	a. Principles and construction of a telegraph sounder b. Principles and construction of telegraph keys c. Sources of electrical energy d. Principles and construction of auxiliary equipment e. How to send a telegram f. How to send a cablegram g. How to compute the cost of telegrams and cablegrams h. The operation of a teletypewriter

Unit B. Automotive Electricity

Things to Do	Things to Know
1. Inspect and sketch an automobile ignition and lighting circuit *Note:* This should be done on a permanent mock-up used only as a teaching aid.	a. Understand the purpose and operation of an automobile ignition system b. Understand the purpose and operation of an automobile lighting and signalling system
2. Test, clean, and adjust spark plugs, distributor points, generator, starting motor, and regulator of an automobile	a. Principles of operation and construction of the parts of the automobile ignition system b. Adjustments which may be made easily to the ignition system by an automobile owner and how to make them c. Proper care and maintenance of the automobile ignition system
3. Test and replace lamps and fuses of the automobile lighting and signal system	a. Methods of adjusting and replacing headlights b. Principles of construction and operation of directional and stop signals c. How to assemble and disassemble the various lamp assemblies and how to replace bulbs

Unit C. Direct Current Machines

Things to Do	Things to Know
1. Generate direct current by mechanical means	a. Theory and operating principles of DC (direct current) generators b. Electrical characteristics of compound-wound, shunt-wound, and separately excited DC generators c. Theory and operating principles of auxiliary control apparatus
2. Test, repair, and rewind direct current generators and motors	a. Testing procedures for grounds, short and open circuits in armatures and fields b. Testing and repair procedures for commutator faults c. Methods for quick repair of armatures d. How to wind armature and field coils e. How to rewind and connect various types of armatures



Things to Do	Things to Know
3. Operate direct current motors	a. Theory and operating principles of DC motors
	b. Electrical characteristics of series, shunt-, and compound-wound motors
	c. Theory and operating principles of manually operated starting rheostats and speed controllers
	d. Theory and operating principles of automatic controllers
	e. The principles of dynamic braking
	f. Maintenance of DC motors

Unit D. Alternating Current Machines

Things to Do	Things to Know
1. Connect transformers in single- and poly-phase circuits	a. Theory of alternating current and its transmission
	b. Connection diagrams for single-phase circuits
	c. Connection diagrams for poly-phase circuits
	d. Basic principles of transformers
	e. Code requirements for transformer installations
	f. Principles of the instrument transformer
2. Generate alternating current	a. Operating principles and construction of three-phase alternators
	b. Parallel operation of three-phase alternators
	c. Wiring for three-phase alternators
	d. Control and auxiliary electrical apparatus

Things to Do	Things to Know
3. Operate single- and polyphase AC motors (fractional H.P. and larger sizes)	a. Construction and operating principles of single-phase fractional horsepower motors b. Methods of starting, control, and speed regulation of fractional H.P. motors c. Electrical characteristics of fractional H.P., single-phase motors d. The construction and operating principles of the three-phase, squirrel cage induction motor. e. The construction and operating principles of the starting compensator. f. The construction and operating principles of the wound-rotor induction motor. g. The construction and operating principles of manual speed controllers for wound-rotor motors. h. The construction and operating principles of the synchronous motor. i. The construction, principles of operation and connection of automatic alternating motor controls. j. The maintenance of alternating current motors.

3 Organization of Instruction

INSTRUCTIONAL MATERIAL AND DEVICES

Significant Projects and Activities

The Industrial Arts practice of teaching the desired skills and knowledges through the use of interest-capturing "take-home" projects is difficult to apply to the study of electricity in either the comprehensive or the unit shop. The difficulties are two-fold and opposite in nature. In the one case the skill or knowledge to be taught simply does not lend itself to project construction. An example of this is teaching the method of replacing a wall switch or a convenience outlet. On the other hand, attempts to motivate the study of electricity through the making of lamps, motors, heating devices and the like have too often resulted in either unacceptably crude replicas or demands upon the pupil for skills in working wood, plastics, sheet metal, ornamental iron or metal machining far beyond his actual abilities or training. *The electrical skills and knowledge needed to make a table lamp for instance are the least of those used to produce an acceptably pleasing and useful product.*

The ingenious and resourceful teacher will recognize these as merely pitfalls and not as limitations. He will find many take-home projects

which do not have these faults and which are high in boy-interest values. These may include such items as crystal and razor blade radios, one-tube radios, oscillators, electric eye adaptations, radio and other test equipment, soldering guns, small motors, repaired appliances and adaptations of signal and other communication devices. It is in the making of these items that the teacher will find opportunity and need for using several of the other activity areas of the shop to make their construction possible. Care must be taken, of course, to see that the electrical skills and knowledges are not subordinated to those needed for the cabinets, bases, containers, frames, etc., which need to be made in these other areas. It is in this intermingling of skills from the various areas that the pupil will demonstrate to himself that the electrician works not only with the materials and processes of electricity but also with other skills, materials, and processes of industry as well.

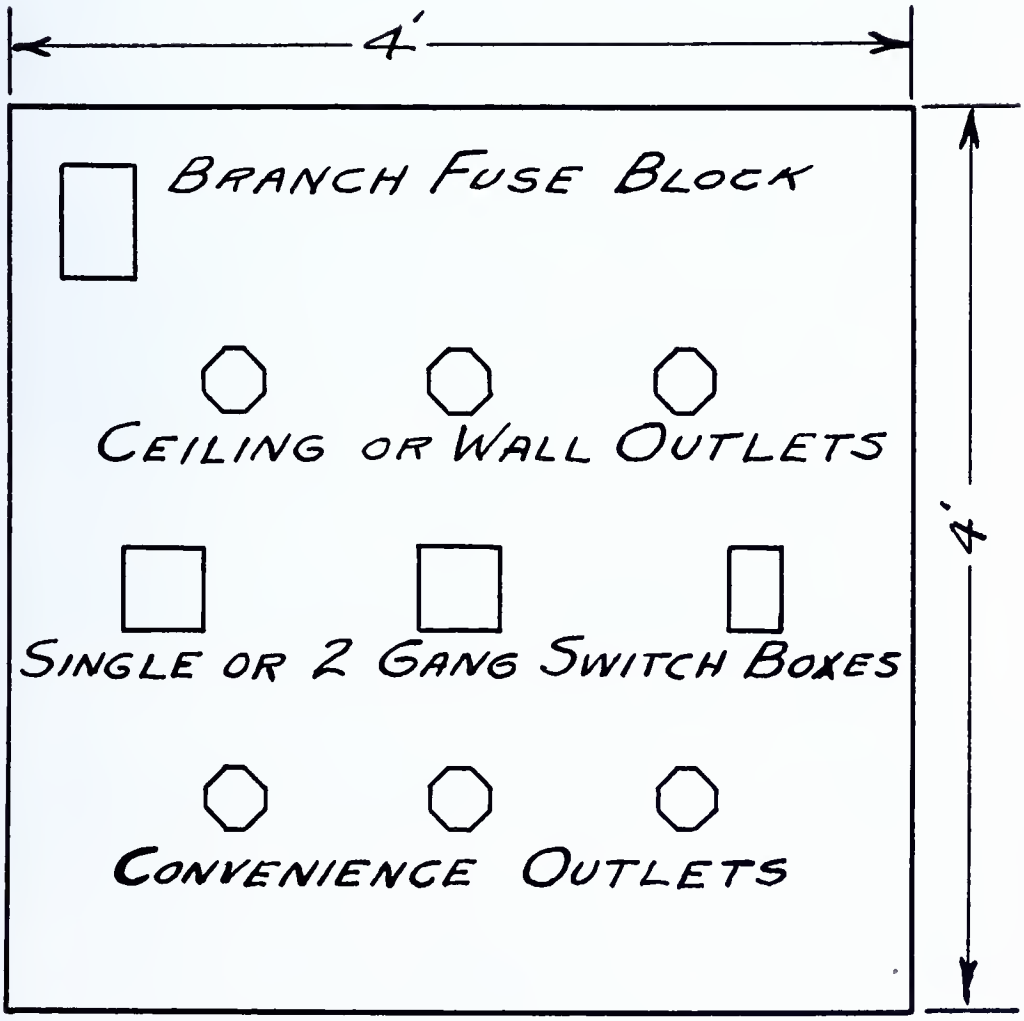
The teacher will find many interest-arousing techniques for presenting those things which must be taught on a laboratory exercise or shop job basis. What will capture the interest of the average boy more than a model electric railroad? A simple arrangement of a few feet of track, an engine and one or two cars powered from a multi-tap transformer, and mounted in a large table drawer (for convenient storage and protection) can be used to teach the fundamentals of transforming alternating current, operation of a universal motor, care and maintenance of commutators and brushes, operation of solenoids, electrical circuits, current-voltage-resistance relationships, contact resistance, splicing, and many other items. This simple railroad system can be expanded to include the teaching of photo-electric cells and relays as they operate crossing gates and switches, the use of complex and multiple circuits to operate several sections of track and auxiliary equipment. Electrical and mechanical interlocks can be used to determine the operating sequences. Many other electrical applications may be introduced. In short, this teaching device is limited only by the needs and desires of teacher and pupils.

The shop and its equipment may provide additional interest-capturing jobs. A toolroom or tool cabinet door may be equipped with an electric door opener. The buttons to control it may be located at the teacher's desk or at another convenient place. The windows and entrance doors may be wired to alarm circuits using open- or closed-circuit relays. The same principle may be used to "booby-trap" selected projects or equipment to an alarm circuit for

protection from disturbance or merely to arouse pupils' interest. If this equipment is fastened to removable plates no undue damage to the building should result from its continued use for pupil wiring.

In advanced classes the routine care and maintenance of shop electrical devices may be used to teach the fundamentals as they apply to home and industrial equipment.

Preconstructed and wired interchangeable plywood panels may be used to advantage to conserve pupil time and focus attention on the objective of the lesson. These panels should be of a standardized size—4′ x 4′ or 4′ x 6′—to fit working frames placed in the shop to give access to the front and rear. They are inserted and removed as needed. These panels may be used for pupil construction, electrical diagnosis and testing, and teacher demonstration. See plan below.



Panels used for pupil construction should contain equipment used for a family of jobs. For example, a panel may be developed for wiring branch circuits, and used to teach skills and knowledges called for in Part II, Unit B, 1 and 2, page 17. All wiring is done on the back of this panel, using metallic or nonmetallic-sheathed cable. A number of wiring combinations of switches, outlets, and lights is possible with such a panel. The outlet boxes and switch boxes only are mounted permanently on this panel with the necessary switches, light fixtures, convenience outlets, cover and escutcheon plates secured from stock as required.

One or more panels may be wired permanently and used for the teaching of home repair jobs (Part II, Unit A, pages 14 to 16). Thus, the pupil is confronted with a situation similar to the actual repair job of replacing a switch, an outlet, or a fixture.

Diagnostic or test panels may be wired and kept on hand. They should be maintained in complete working order. The teacher may then introduce one or more faults for the pupil to locate and correct, giving practice and instruction in electrical trouble-shooting. The pupil can also be given practical tests on this device.

Single panels or a series of panels may be developed by the teacher for demonstration purposes. Radio circuits and automotive electrical systems lend themselves especially well to this type of teaching. The necessary items of equipment are mounted on the front of the panel in proper relationship. If desired, the complete electrical diagram, including symbols, may be painted on the panel in color with the necessary wiring done over the painted diagram.

Where lack of storage space or other factors prevents the use of portable, interchangeable panels, the same results on a limited scale can be secured by making the panel a permanent part of the working frame along one wall or erected perpendicular to the wall in a series of partitions forming booths.

Emphasis in this activity is necessarily on *instruction* rather than *construction*. Projects must be carefully considered for practicability, usefulness, suitability, and safety. A project or job which is far-fetched, and in which a boy can see no possible use, obviously will fail as a teaching device. Likewise, no boy or girl will be able to develop enthusiasm for making a device which is less suitable for its intended use, and perhaps more costly than can be purchased.

The teacher should be certain that all jobs and projects conform in every applicable particular to the standards and specifications set forth in the National Electric Code and other publications of the National Board of Fire Underwriters. Failure to adhere to these standards may result not only in immediate danger but in the formation of consumer habits leading to the acceptance of substandard and dangerous practices.

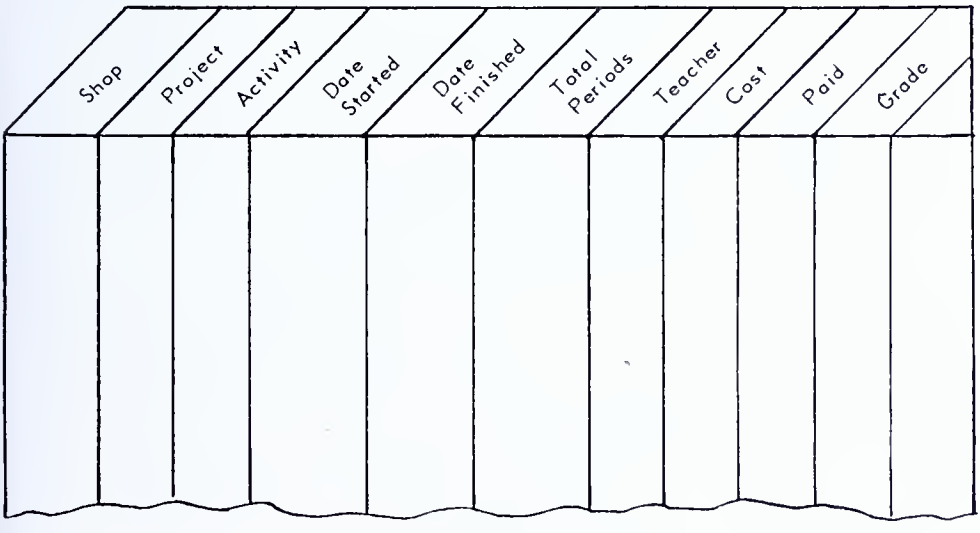
Use of Records, Forms, and Charts

The Industrial Arts teacher of a comprehensive shop program is confronted with many problems pertaining to the administration of the program, details of instruction, and the handling of supplies. The problems increase as the activities in the shop become more diversified. Development of adequate record-keeping forms and charts, and the maintenance of accurate up-to-date records are an important responsibility of the Industrial Arts teacher. If properly developed, record-keeping will not be time-consuming and monotonous, but will aid the teacher in showing daily teacher-pupil progress. Such records should also prove useful in the evaluation, development, and improvement of

Name Grade 7 8 9 10 11 12 PG

PUPIL CUMULATIVE PROJECT RECORD

Industrial Arts Department School City



Sample of a Cumulative Project Record Form to be Kept Throughout a Pupil's School Experience in His Work in the Electricity Area.

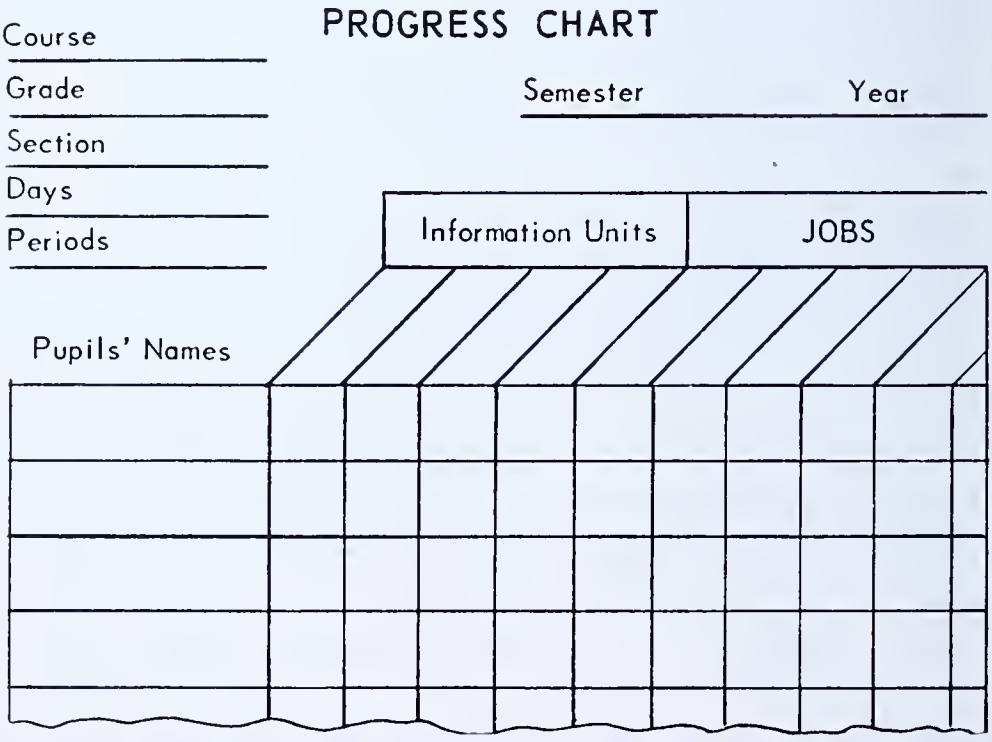
the instructional program. Care should be taken, however, that the teacher does not become so involved with record-keeping that he becomes a mere clerk. Instead, a plan can be devised whereby pupils and teacher share the work of recording pupil progress in the learning units.

The Cumulative Project Record Card

The Cumulative Project Record Card is a convenient and organized device for keeping a record of each pupil's progress and his experiences in making projects. It is helpful to the teacher in planning the instructional program for each pupil from semester to semester or from year to year. It is also valuable to those responsible for guidance, placement, and follow-up. See sample on page 35.

Progress Chart

The Pupil Progress Chart will aid the teacher to control pupil advancement. It is desirable that all pupils have an understanding of elementary electrical principles, and fundamental skills needed to handle tools, wires and basic electrical devices found in the electrical field. The specific projects, jobs, exercises, and informational units which each teacher selects to accomplish this will, of course, vary with



Sample Progress Chart to Show Accomplishment of Pupils Throughout the School Year

the time and equipment available, grade level and ultimate objective of the course. The chart should show these requirements and the pupils' progress through them. Later units are not interdependent and need not be taught in a particular sequence. It is not necessary or desirable that all pupils study the same units, or even any one unit to the same extent. Therefore, a record of each pupil's accomplishment is needed for day-by-day assignments, term scheduling, and later reference. A suggested progress chart is shown on page 36.

Instructional Materials

When shop work was first introduced into the public schools, teachers felt that it provided a means of escape from the "drudgery" of books. Because of this fact, very little use was made of written instructional materials in the teaching of Industrial Arts. In recent years, however, since interest in the comprehensive general shop has increased, instructors are aware that the multi-activity shop can be taught most effectively through the use of instruction sheets. Written instruction sheets are of great value in giving specific directions quickly to the pupil or to a group who have different backgrounds, interests, and abilities.

Instruction Sheets. Instruction sheets are particularly helpful in giving individual instruction where pupils progress independently at their own speed.

Some advantages in using written instructional material are:

1. The teacher has more time to select instructional material and to arrange it in the best learning order.
2. More accurate instructions are possible.
3. The responsibility to seek out information is placed on the student.
4. Accurate record keeping and checking can be carried on easily.
5. The teacher has more time for helping individual pupils.

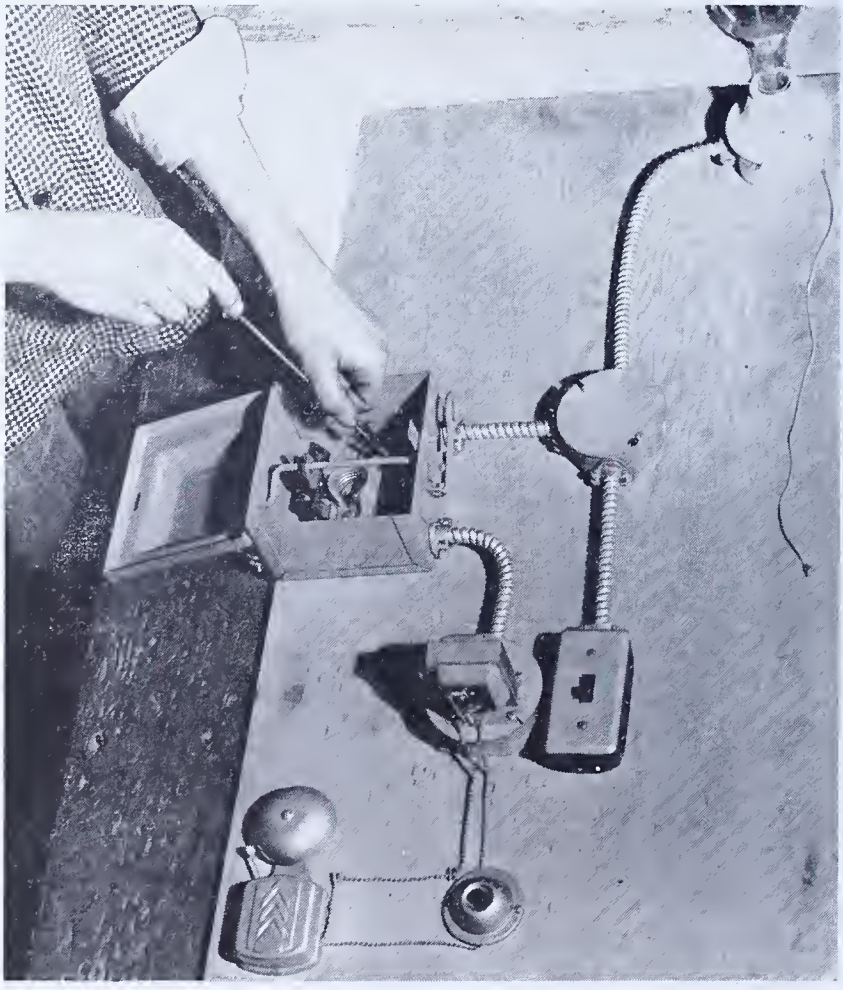
Procedures and Techniques

It is important to get pupils started in the right manner. The objectives, methods, procedures, and teaching devices must be planned and explained so as to emphasize that the shop is a place to learn things as well as to make things. Teaching does not consist primarily of

telling and showing but rather in providing shop experiences which interest the pupils and create the desire to learn.

The practical and informational learning units in Electricity are comprehensive, providing experiences in all areas ranging from the simple to the complex. Considerable flexibility exists in content. Part 2—Learning Units—provides a basis for selection of units of instruction most applicable to the needs and interests of the group, or the individual pupil.

Success in teaching Electricity as an Industrial Arts activity depends largely on proper planning of instruction and the development of instructional materials, such as information sheets (see sample, page 39), sample pupil project assignment sheet, (see sample, page 42), and operation sheets (see sample, page 45).



SAMPLE PUPIL INFORMATION SHEET

Part I: Understanding Electricity

Unit B: Making Electrical Pathways

Information Sheet No. 6

EXTENSION CORDS

References:

1. *Industrial Arts Electricity,* Lush and Engle, pages 72 and 86.
2. *National Electric Code,* Articles 400, 410, 940, 941, Chap. 10, Table 31.
3. *Fundamental Jobs in Electricity,* Perry and Schafebook, page 149.

Extension cords are used to conduct electricity from the place where it is available to the place where it is needed in much the same way that a garden hose conducts water from the tap to the garden bed. An extension cord provides a flexible connection between a portable electrical appliance and a house circuit. It should not be used as a *permanent* electrical connection. (One would not use a garden hose inside a house in place of pipes.)

Precautions

If you were able to connect several garden hoses to the same outside water tap you couldn't expect each hose to deliver a full stream of water from its nozzle. Likewise, when you connect several extension cords to the same outlet, you cannot expect to get full service from each. If you connect several extension cords to the same outlet and connect them to appliances used at the same time, you may be overloading the wires leading to the outlet. These wires may become dangerously hot and may eventually start a fire. This is especially true if one should be so unwise as to replace proper fuses with those of a higher rating because the first ones keep burning out.

Materials

Extension cords are assembled from many types of materials depending on their use.

Plug caps are available in several styles and kinds. Some are "polarized" so that they will fit special sockets only. Some are rubber-covered for use in damp places. Some are made of Bakelite for general use in dry locations. Others are made with metal covers and have clamps to hold the wire tight for use under rough service conditions. Select the one most suitable for your particular use.

Sockets or *lampholders* are also made in several types. The more common one is made with a brass shell containing a porcelain or composition center which houses the working parts. They usually are made with a switch which can be operated by a key, push button, or pull chain. A keyless socket is also made. Some sockets are rubber-covered and are called "weatherproof" sockets. The most common socket is built to receive a *medium base* bulb. Larger sockets are made to receive *mogul base* bulbs.

Extension cords are made from flexible, stranded wires covered in several ways to provide adequate insulation and protection from wear. They are commonly furnished with two wires wound or wrapped to form a pair of conductors. Other flexible cords are made with three or more conductors wrapped to form one cord. Table 31 in Chapter 10 of the 1951 Edition of *National Electric Code* lists 22 different trade names for flexible cords, made in 46 different types.

The most common type, called *lamp cord,* (Type C) is a twisted pair of flexible wires, each insulated with rubber, and covered with green and yellow cotton braid. This cord is usually sold in size No. 18 A.W.G. or larger, and is used on pendant or portable appliances used in dry places where the cord will not be subject to hard usage.

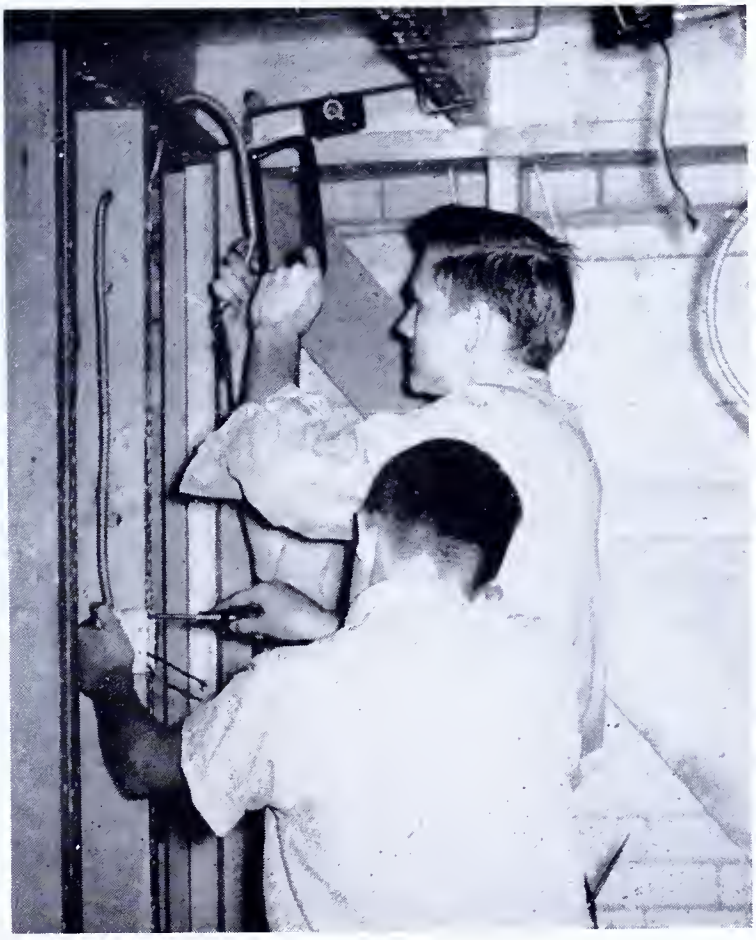
Another common flexible cord (Type PO-64) is one made of two parallel rubber-covered wires. This wire is normally sold only in size No. 18 A.W.G. and is used on pendant or portable appliances used in damp or dry locations where the cord will not be subject to hard usage.

Another widely used flexible cord (Type S) is called *hard-service cord.* This cord is made with a pair or more of wires, each insulated with rubber and then covered with an outer rubber cover which may be oil resisting (Type SO). The cord is made in size No. 18 A.W.G. or larger and is used on pendant or portable appliances used in damp or dry locations where the cord may be subjected to very hard usage.

Asbestos-covered cords are made for appliances subjected to high heat. Other coverings are used for hazardous locations.

QUESTIONS:

1. What combination of plug, socket, and cord is suitable for an extension to be used for an electric drill located in the basement?
2. What flexible cord is suitable for making a long extension cord to use with hedge clippers?
3. What are the hazards of using an extension cord with a brass shell socket in the bathroom?
4. What is a "polarized" plug?
5. Where should a "weatherproof" socket be used?



SAMPLE PUPIL PROJECT ASSIGNMENT SHEET

Part I: Understanding Electricity

Unit B: Making Electrical Pathways

Job Sheet No. 4

TO MAKE AN EXTENSION CORD

References:

1. Lush and Engle, *Industrial Arts Electricity,* page 86.
2. *National Electric Code,* articles 400, 410, 940, 941.
3. Perry and Schafebook, *Fundamental Jobs in Electricity,* page 149.

Tools and Materials:

3-inch screwdriver, 6-inch side-cutting pliers, wire-skinning knife, length of extension cord, attachment plug, pendant socket, socket cap with bushing.

Procedure:

1. Separate the wires for a distance of about two inches on each end by carefully cutting the rubber or braid which encloses both. Be careful not to cut into the insulation which encloses each wire.

Fig. 1. *Stripped wire*

2. Slip the socket cap over one end of the cord, and the plug cap over the other end. (Fig. 2 and Fig. 3.)
3. Wrap each end of the cord (at the point where the braid or rubber has been cut) with a few turns of tape, ¼-inch wide, to prevent fraying.
4. Tie an Underwriters' knot at each end of the cord. (See Fig. 2 and Fig. 4.)
5. Remove about ½-inch of insulation from each end of the four wires. Twist the strands of each tightly together. Remove the insulation carefully so as not to cut any of the small strands and thus reduce the current-carrying capacity of the wire. (See Fig. 1.)

6. Connect the two wires at the one end of the cord to the terminal binding screws of the pendant socket. (See Fig. 2, lower part of figure.) Make sure that tightening these screws also tightens the wire loop on the cord.

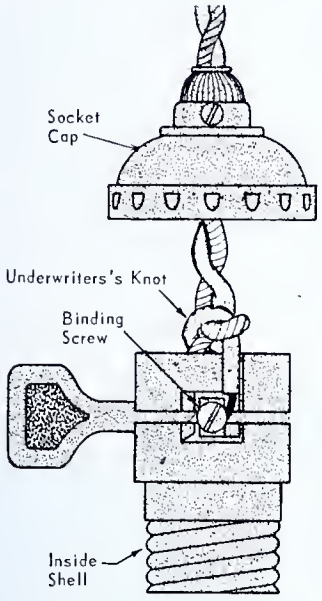


FIG. 2. *Inside of pendant socket*

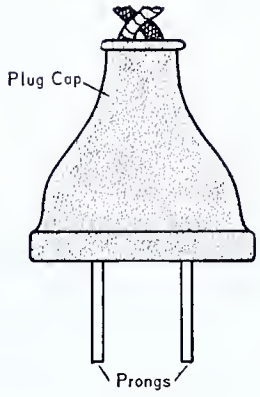


FIG. 3. *A plug cap (bottom shown in Fig. 4)*

7. Connect the two wires at the other end of the cord to the terminal screws of the plug cap after looping each around a prong. Loop the wire strands clockwise under the head of each screw. (See Fig. 4.)

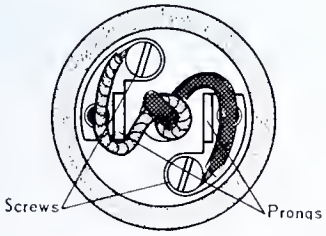


FIG. 4. *Underwriters' knot (center) on plug cap*

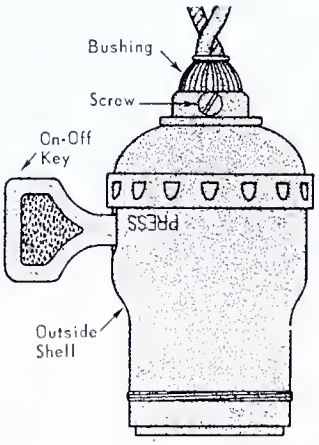
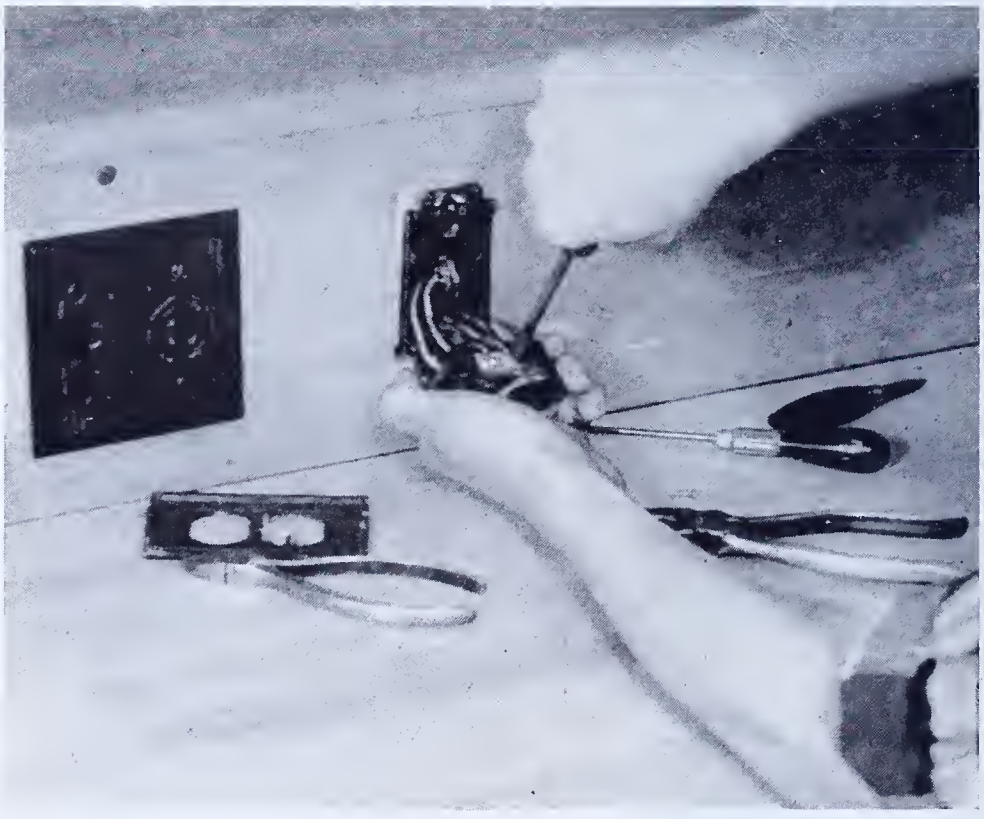


FIG. 5. *Pendant socket, cap snapped in place*

8. Be sure that no loose strands of wire are protruding from under the heads of the terminal screws to cause a short circuit or ground on the plug cap and the socket cap. Pull on the cord to be sure the strain of the pull is taken by the Underwriters' knot and not by the wires under the terminal screws.

9. Have your work checked by the teacher, replace the insulator and shell of the socket, and snap the cap in place. (See Fig. 5.)

10. Test your extension cord by putting a light bulb in the socket, and plugging it into a 115-volt circuit.



SAMPLE PUPIL OPERATION SHEET

Part I: Understanding Electricity

Unit B: Making Electrical Pathways

Operation No. 4

TO TIE AN UNDERWRITERS' KNOT

References:

1. Lush and Engle, *Industrial Arts Electricity,* page 87.
2. *National Electric Code,* Articles 4009, 4145.
3. Perry and Schafebook, *Fundamental Jobs in Electricity*, page 156.

Tools and Materials:

Short lengths of paired electrical conductors or sash cord.

Why this Operation is Important:

The weight of drop cords and the pull on extension cords must be borne by the *entire* lamp cord—its insulation, its braid, and its copper conductor. In no case should the pull and weight be borne by only the copper conductor. See Fig. 1 to learn how the Underwriters' Knot rests snugly in the plug so that the knot holds against weight or pull put on the wire. This knot prevents short circuits caused by the conducting wires being pulled from the plug.

Fig. 1

PROCEDURE:

1. Follow the steps illustrated in Figures 2 through 5:

Fig. 2

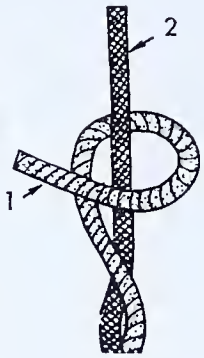


Fig. 3

Fig. 4

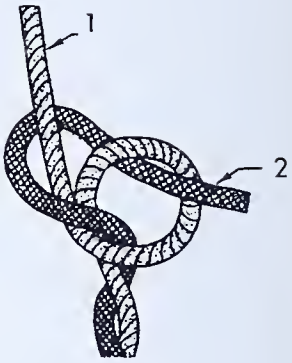


Fig. 5

Figure 2 shows the first position of wires 1 and 2.
Figure 3 shows how to bring wire 1 around wire 2.
Figure 4 shows wire 2 brought around wire 1, and
Figure 5 shows wire 2 brought through the loop formed by wire 1.

2. Pull wire 2 to tighten the knot.

3. Take your Underwriters' Knot to the teacher for approval.

SAMPLE PUPIL PROJECT PLAN

..... High School

..... School District

Name..... Grade..... Section.....

Project..... Teacher Approval..... Date.....

Sketch: Make a working sketch of the project to be made.

Procedure: List the principal steps in doing the job, showing what you will do first, second, third, etc.

1. .....
2. .....
3. .....
4. .....
5. .....

REVERSE SIDE OF PUPIL PROJECT PLAN

Bill of Material and Time Sheet

Number or Amount	*Description or Name of Item*	*Size or Capacity*	*Unit Price*	*Cost*

Cost of material ..... _____

Time spent was _____ hrs. @ _____ per hr. ..... _____

Total direct cost ..... _____

Standard time for the job:_____hrs. _____

Shop Management Organization

As the activities presented in Industrial Arts shops are increased in number and scope, it is expedient for the teacher to assign some of the routine duties to pupils. The purpose and the plan itself will not be the same for all schools, depending on the activities offered, size of class, age of students, length of periods, and physical layout of the shop. This cooperative plan is an effective device for achieving the following common Industrial Arts objectives:

1. To present practice in leadership and "followership."
2. To motivate the pupils' understanding of industrial operations and applications.
3. To develop responsibility and a feeling of belonging to the activity.
4. To aid the teacher in many routine duties.

The shop management activities should be planned and organized by the class. A teacher-imposed plan is readily recognized by the pupils, and has a tendency to destroy pupil interest. Better cooperation can be developed therefore through a personnel plan developed by the pupils with teacher guidance and direction. Pupils may assist in the development of the plan as a class or through a committee of pupils from several classes. A plan developed in this manner motivates the pupils' interest in industrial personnel organization and provides an incentive for the study of local plant personnel systems. The extra time spent in the democratic development of this plan is more than compensated by the added cooperation attained by the teacher, and the guidance value received by the pupils.[1]

In order to make a pupil shop management plan operate successfully, the importance, need, and practicability must be explained carefully to the pupils. The success of the program depends entirely upon the pupils' acceptance; therefore, the teacher should plan his presentation carefully in order to justify the value and need of such a program.

A check list for periodic evaluation of the condition of the shop appears below, which may be used by the pupil foreman in evaluating and checking the work of the clean-up personnel.

[1] Suggestions for the development of a pupil personnel organization plan is given in *Industrial Arts in Pennsylvania,* Bulletin 331, 1951, page 83.

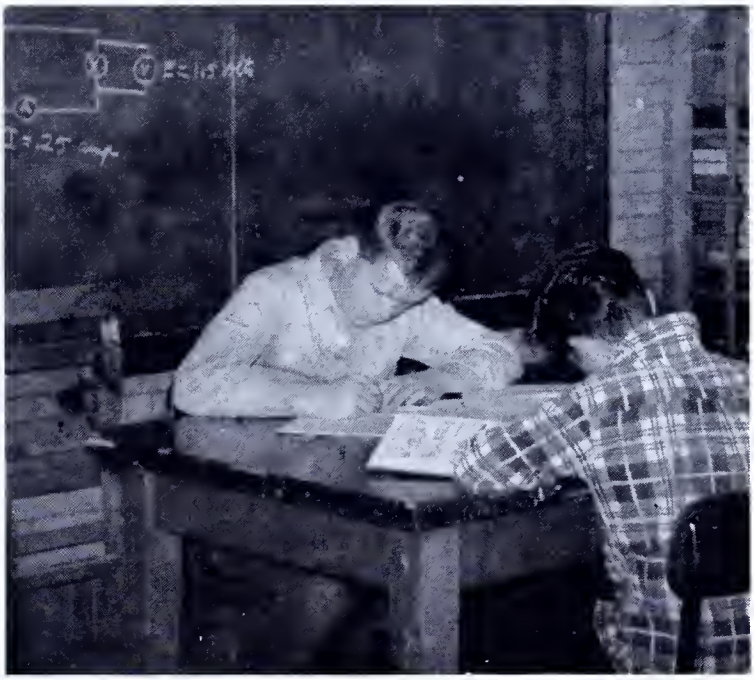
PARTIAL CHECK LIST ON CARE OF THE SHOP

	Teacher	*Yes*	*No*
1.	A place for everything		
2.	Everything in its place		
3.	Benches and machines well arranged		
4.	Movable benches and machines in proper place		
5.	Tools sharp		
6.	Tools in good repair		
7.	Equipment in good repair		
8.	Machines properly and regularly lubricated		
9.	Shop circuits properly protected		
10.	Electrical hazards properly guarded		
11.	Machines properly guarded		
12.	Circuits not overloaded		
13.	Bulletin board orderly		
14.	Material on bulletin board changed frequently		
15.	Teacher's desk orderly		
16.	Oily and acid-soaked rags placed in metal container		
17.	Student shop organization fairly selected and properly posted		

	Foreman		
1.	Machines cleaned properly		
2.	Electrical equipment properly disconnected		
3.	Tools clean, in racks, and all accounted for		
4.	Store room in order		
5.	Broken porcelain reported to teacher		
6.	Blackboard clean		
7.	Floor clean		
8.	Wire remnants separated from other trash		
9.	Shop library in order		
10.	Lockers orderly		
11.	Sink and fountain clean		
12.	Clean-up tools in proper place		
13.	Jobs and projects properly marked or stored		
14.	Wiring diagrams and other instructional material returned to proper places		
15.	Windows closed		
16.	Blinds properly drawn		
17.	Containers empty and returned to their proper places		

4 Instructional Aids

BOOKS, MAGAZINES, BULLETINS, FILMS



In a bulletin of this size it is not possible to list all available instructional material in the form of books, pamphlets, study guides, charts, and catalogs. However, an attempt has been made to list certain instructional materials with publisher, date, number of pages, author, and an annotation of the contents for each item of instructional material so that the Industrial Arts teacher will know what they contain.

Because any bibliography is out of date soon after its issue, the Industrial Arts teacher should read announcements and advertisements in professional journals so that he will know about the issuance of new instructional material.

BOOKS

Abbott, Arthur L., *National Electric Code Handbook.* New York, N. Y., McGraw-Hill Book Company, Inc., 1951. 633 pp. $4.00

A handbook planned to explain and interpret the National Electric Code so as to enable electricians to work in accordance with its provisions. A reference book of value to any shop engaged in practical wiring.

Buchsbaum, W. H., *Television Servicing.* New York, N. Y., Prentice-Hall, Inc., 1950. 350 pp. $4.00

A nonmathematical text which explains the theory of television, outlines the entire system, describes the alignment and installation of a receiver, and presents a guide for servicing. This book is primarily intended for students who have had some previous training in radio. A number of receiver diagrams are available in a separate booklet.

Collins, M. D., *Projects in Electricity.* Bloomington, Ill., McKnight and McKnight Publishing Co., 1941. 80 pp. $1.20

This book suggests 21 inexpensive projects which demonstrate many basic electrical principles. Step-by-step instructions are illustrated with drawings, and pupils' initiative is stimulated on interesting projects. Simple tools are used in all construction. The projects include: low-frequency buzzer, simple buzzer, high-frequency buzzer, two-coil buzzer, vertical two-coil buzzer, new-type buzzer, single bell, two-coil bell, telegraph set, vertical motor, wood and metal motor, magnetic vertical motor, two-pole armature motor, power motor, two-pole motor, three- and four-pole motors.

Cook, S. R., *Electrical Things Boys Like to Make.* Milwaukee, Wis., Bruce Publishing Co., 1942. 216 pp. $2.75

This book features simple directions and detailed drawings for 33 projects which interest boys.

Cornetet, W. H., *Principles of Electricity.* Bloomington, Ill., McKnight and McKnight Publishing Co., 1952. 342 pp. $4.00

A second edition designed for secondary schools to help the pupil to understand basic electricity and electronics. The book contains many experiments for practical applications of electricity.

The book covers magnetism; static electricity; Ohm's Law; electrical currents and chemical action; energy, work, power; electricity and magnetism; electrical meters; DC and AC motors and dynamos; electronics.

Croft, Terrell, *American Electricians Handbook.* New York, N. Y., McGraw-Hill Book Company, Inc., 1948. 1734 pp. $6.00

A complete reference library for the practical electrician. This book could form the nucleus of a reference library for shops specializing in one or more electrical fields.

Crouse, William H., *Everyday Household Appliance Repairs.* New York, N. Y., McGraw-Hill Book Co., Inc., 1952. 295 pp. $4.95.

This book describes how household electrical appliances are constructed and operate. It outlines what is needed to keep appliances in repair. The users will be quick to sense trouble and save many expensive repairs if he knows how equipment is constructed. This book covers home appliances from waffle iron and toaster to refrigerators and freezers. Wiring diagrams and trouble-shooting charts are included for each appliance to make it possible for the average person to follow the necessary steps for maintenance.

Crouse, William H., *Electrical Appliance Servicing.* New York, N. Y., McGraw-Hill Book Co. Inc., 1950. 854 pp. $8.50

This book is designed to assist the man engaged in servicing appliances and to serve as a pupils' text. It supplies necessary basic information on electrical and mechanical fundamentals, as well as details of construction, operation, and servicing of various appliances.

Dragoo, A. W., and Dragoo, K. L., *General Shop Electricity.* Bloomington, Ind., McKnight & McKnight Publishing Co., 1952. 120 pp. $1.25

The revised edition of a workbook in elementary electricity. It contains designs for many practical projects.

Eaton, J. R., *Beginning Electricity.* New York, N. Y., The MacMillin Company, 1952. 361 pp. $5.50

An exposition of the fundamental practices and theories in electricity.

Delmar Publishers, *Electrical Motor Control.* Albany, N. Y., 1946. 149 pp. $3.25

This vocational workbook could be used for reference in the Industrial Arts program where direct and alternating current motors are being intensively studied. Many types of controls are illustrated with wiring and connection diagrams. The treatment is introductory rather than exhaustive, so the pupil is not confronted with a maze of detail.

Delmar Publishers, *General Electricity (Related Information).* Albany, N. Y., 1952. 181 pp. $2.25

Developed by the New York State Education Department, this book was prepared expressly for the electrical unit of a general shop program. It enables the teacher to present suitable related information. Content includes planning, social economics, guidance, safety and hygiene, and consumer values.

Fisher, Howard W., and Crowly, Frank J., *Elements of Electrical Drawing.* Manchester, Conn., Electro-Technical Publishing Co., 1952. 100 pp. $2.75

A workbook of electrical drafting projects designed to stimulate interest in electricity. It is self-teaching to a large degree.

Ford, Walter B., *Electrical Projects for the School and Home Workshop.* Milwaukee, Wis., Bruce Publishing Co., 1948. 176 pp. $3.00

Each of the 34 projects described in this book is accompanied by a bill of materials, working drawings, and a picture of the completed project.

Ghirardi, Alfred A., and Johnson, J. Richard, *Radio and Television Receiver Circuiting and Operation.* New York, N. Y., Rinehart Books, Inc., 1951. 669 pp. $6.00

A practical discussion of the circuits and principles of radio and television receivers, recorders, and record players, including the characteristics of AM, FM, and TV waves. A valuable reference book for the radio and television library.

Ghirardi, Alfred A., and Johnson, J. Richard, *Radio and Television Receiver Trouble Shooting and Repair.* New York, N. Y., Rinehart Books Inc., 1952. 822 pp. $6.75

Radio and television receiver servicing is covered completely in everyday language. The book provides solutions to problems in all types of AM, FM and

TV receivers, and gives step-by-step procedures with many charts, tables, and illustrations. A valuable reference book for the radio and television library.

Gorder, L. O., Hathaway, K. A., and Dunlap, C. H., *Fundamentals of Radio.* Chicago, Ill., American Technical Society, 1943. 373 pp. $3.00

Assuming that the pupil has had no previous knowledge on the subject, this book leads the reader step by step through the fundamentals of radio receivers and transmitters. Mathematics has been reduced to simple arithmetic. The book has a companion study guide which sells for $1.25. The content includes the development of radio, symbols, principles of electricity, magnetism and electromagnetism, resistance, direct and alternating currents, measuring instruments, inductance and electromotive force, condensers, capacitance, oscillatory circuits, resonance, tubes, amplifiers, acoustics, microphones, radiotelegraph transmitters, amplitude-modulated broadcast transmitters, antennas, receivers, frequency modulation, and a dictionary of terms.

Graham, Kennard C., *Small Commutator Motors.* Chicago, Ill., American Technical Society, 1952. 283 pp. $4.90

This book focuses attention on the many types of small home and industrial motors, both AC and DC which are commutator operated. The text covers the theory of operation, construction, testing, and repair of the various repulsion type and direct current motors, including universal motors. The hand- and machine-winding of coils and armatures is treated with the methods of winding and connecting the coils to the commutator. This text finds its greatest application in those Industrial Arts shops where motor repair is covered intensively.

Graham, K. C., and McDougal, W. L., *Small Non-Commutator Motors.* Chicago, Ill., American Technical Society, 1951. 265 pp. $4.25

This book covers the construction, theory of operation, testing and repair of most small alternating current motors found in the average home. Actual projects have step-by-step procedures for servicing motors. Charts and tabulations analyzing motor trouble for common types of motors are included. This text will be of greatest use in those Industrial Arts shops where small motor repairs and rewinding are studied intensively.

Hausmann, Erich. *Swoope's Lessons in Practical Electricity.* New York, N. Y., Van Nostrand and Company, Inc., 1926. 694 pp. $4.80

This book, now in its eighteenth edition, has long been a standard text in beginning electricity.

Jones, E. W., *General Electricity.* Bloomington, Ill., McKnight & McKnight Publishing Co., 1950. 90 pp. $1.00

This workbook contains instruction in common electrical knowledges and skills. Questions enable the pupil to check his mastery of one unit before proceeding to the next. A few projects are explained. The book includes magnetism, bells and buzzers, current, voltage, batteries, resistance, conductors and insulators, kilowatts, fuses, circuits, cords, heating devices, safety rules, lighting, generators, motors, induction coils, transformers, auto circuits, telephone, telegraph, radios, defects in circuits, and soldering.

Lehman, Herbert G., *Shop Projects in Electricity.* New York, N. Y., American Book Co., 1934. 190 pp. $.96

This book is prepared primarily for the junior high school student. The 21 projects are graded, practical, and interesting. They range from a pocket compass to a one-tube radio receiver. It is a valuable source book for general shop electricity.

Lush, C. K., and Engle, G. E., *Industrial Arts Electricity.* Peoria, Ill., Chas. A. Bennett Co., 1946. 144 pp. $2.48

This book is planned for the junior high school level. All fundamentals of electrical jobs and work are covered in language a boy can understand. The text is well illustrated. Contents include magnetism, sources of electricity, flow of electricity, circuit wiring of low-voltage, heating devices, lighting, house wiring, conduits and switches, transmission of electricity, power, generators, and motors.

Marcus, A., Marcus, W., and Horton, R. E., *Elements of Radio.* New York, N. Y., Prentice-Hall, Inc., 1948. 751 pp. $3.75

This text, of which over a million copies have been sold to date, stresses radio set construction. It is a "how-to-do-it" book containing laboratory problems and demonstrations. Each principle is covered by an elementary explanation, then more fully developed in a later chapter.

Marcus, A., *Radio Servicing.* New York, N. Y., Prentice-Hall, Inc., 1948. 775 pp. $4.50

The book shows how to disassemble and assemble a radio, and is nonmathematical as well as nonengineering in approach.

McDougal, W. L., Keith, F. E., and Ranson, R. R., *Direct Current Motors and Generators.* Chicago, Ill., American Technical Society, 1947. 326 pp. $3.25

This book presents the practical side of the upkeep of direct current motors and generators.

Miller, Samuel C. and Fink, Donald F., *Neon Signs.* New York, N. Y., McGraw-Hill Book Company, Inc., 1935. 288 pp. $3.50

The manufacture, installation, and maintenance of neon signs.

Moreton, D. P., Dunlap, C. H., and Drinkall, L. R., *Armature Winding.* Chicago, Ill., American Technical Society, 1938. 289 pp. $2.50

This book could serve in Industrial Arts as a reference on construction, winding, and repairing of AC and DC motors.

Morgan, Alfred P., *Getting Acquainted with Electricity.* New York, N. Y., D. Appleton-Century Co., 1942. 346 pp. $3.00

A readable text written for the junior high school level presents material for getting acquainted with electricity and radio.

Perry, Edgar C. and Schafebook, Harry V., *Fundamental Jobs in Electricity.* New York, N. Y., McGraw-Hill Book Company, Inc., 1952. 306 pp. $3.60

This textbook provides basic instructional material for introductory courses in electricity. The material is developed in a step-by-step manner so that the student may progress at his own speed with a minimum of personal direction.

The book contains 134 projects and jobs written as separate assignments. The material includes the fundamentals of electricity, safety, house and signal wiring, generators, motors, transformers, refrigeration, automobile wiring, and other electrical appliances.

Radio Amateurs Handbook, The. West Hartford, Connecticut, The American Radio Relay League, 1951. 539 pp. $3.50

This book covers all radio applications of interest to the amateur operator for both speech and code. The pupil may select from its many transmitters and receiver circuits in building his own equipment.

Richter, Herbert P., *Practical House Wiring.* Wilmette, Illinois, F. J. Drake and Company, Inc., 1952. 602 pp. $4.75

A practical book on all phases of wiring homes, farm buildings, and other small structures. It is based on the 1951 code and includes construction conforming to it.

Rosenberg, Robert, *Electric Motor Repair.* New York, N. Y., Rinehart Books, Inc., 1946. 551 pp. $5.00

This is a "duo-book" containing in one binding a section (243 pp.) of illustrations and diagrams for AC and DC motors and controllers and a section (308 pp.) on text material covering electrical motor repair, winding, and trouble-shooting. It is a text for advanced motor work.

Schuhler, Albert A., *Electric Wiring.* New York, N. Y., McGraw-Hill Book Company, Inc., 1943. 400 pp. $3.00

A complete introductory course in electrical wiring from the making of splices and joints to instruction in more complex wiring circuits. The instruction is presented in job form.

Suffern, M. G., *Basic Electrical Principles.* New York, N. Y., McGraw-Hill Book Company, Inc., 1949. 430 pp. $3.20

This text covers the fundamentals of electricity and presents them simply. It includes an introduction to electricity, batteries and circuits, electromagnetism, alternating current, inductance and capacitance and their effects, generators, motors, electric meters, and the rectification of alternating current.

Uhl, A., Dunlap, C. H., and Flynn, F. W., *Interior Electrical Wiring and Estimating.* Chicago, Ill., American Technical Society, 1941. 312 pp. $3.95

A standard reference containing the latest code changes. Well-illustrated and containing a special section on farm wiring. Very useful for the shop teaching home wiring.

Watson, Herbert M., Welch, Herbert E., and Eby, George S., *Understanding Radio.* New York, N. Y., McGraw-Hill Book Company, Inc., 1940. 601 pp. $3.00

A text and laboratory book for high schools presenting the fundamentals of radio circuits in a step-by-step style.

Yates, Raymond F., *Super-Electricity.* New York, N. Y., D. Appleton-Century Co., 1942. 165 pp. $2.50

An interesting introduction for youngsters to the field of electronics. While

this book is not written as a school text, it does explain the basic principles of electronics and shows many fundamental applications of the photoelectric cell and other electronic equipment to industry.

FILM SOURCES

Audio-Visual Aid Catalog. Bulletin 208, Commonwealth of Pennsylvania, Department of Public Instruction, Harrisburg, Pennsylvania.

Castle Films, 30 Rockefeller Plaza, New York 20, N. Y.

Educators' Guide to Free Films, Educators' Progress Service, Randolph, Wis.

Encyclopaedia Britannica Films, 1150 Wilmette Ave., Wilmette, Ill.

General Motors Corp., General Motors Building, Detroit, Mich.

Jam Handy Organization, 2900 E. Grand Blvd., Detroit 11, Mich.

Library Films, 25 W. 45th St., New York 19, N. Y.

Modern Talking Picture Service, 339 Blvd. of the Allies, Pittsburgh 22, Pa.

National Military Establishment, Public Information, Pictorial Branch, Washington 25, D. C.

United World Films, 1445 Park Ave., New York 29, N. Y.

Westinghouse Electric Corp., Pittsburgh 30, Pa.

FILM TITLES

Electric Motors for the Farm. U. S. Department of Agriculture, Washington 25, D. C.

First Steps in First Aid. U. S. Department of Interior, Bureau of Mines, Washington 25, D. C., 16 mm., sound, 31 minutes, free.

Safety Rules for Electric Fences. U. S. Department of Commerce, National Bureau of Standards, Washington 25, D. C.

Safety Rules for Radio Installations. U. S. Department of Commerce, National Bureau of Standards, Washington 25, D. C.

Solders and Soldering. U. S. Department of Commerce, National Bureau of Standards, Washington 25, D. C.

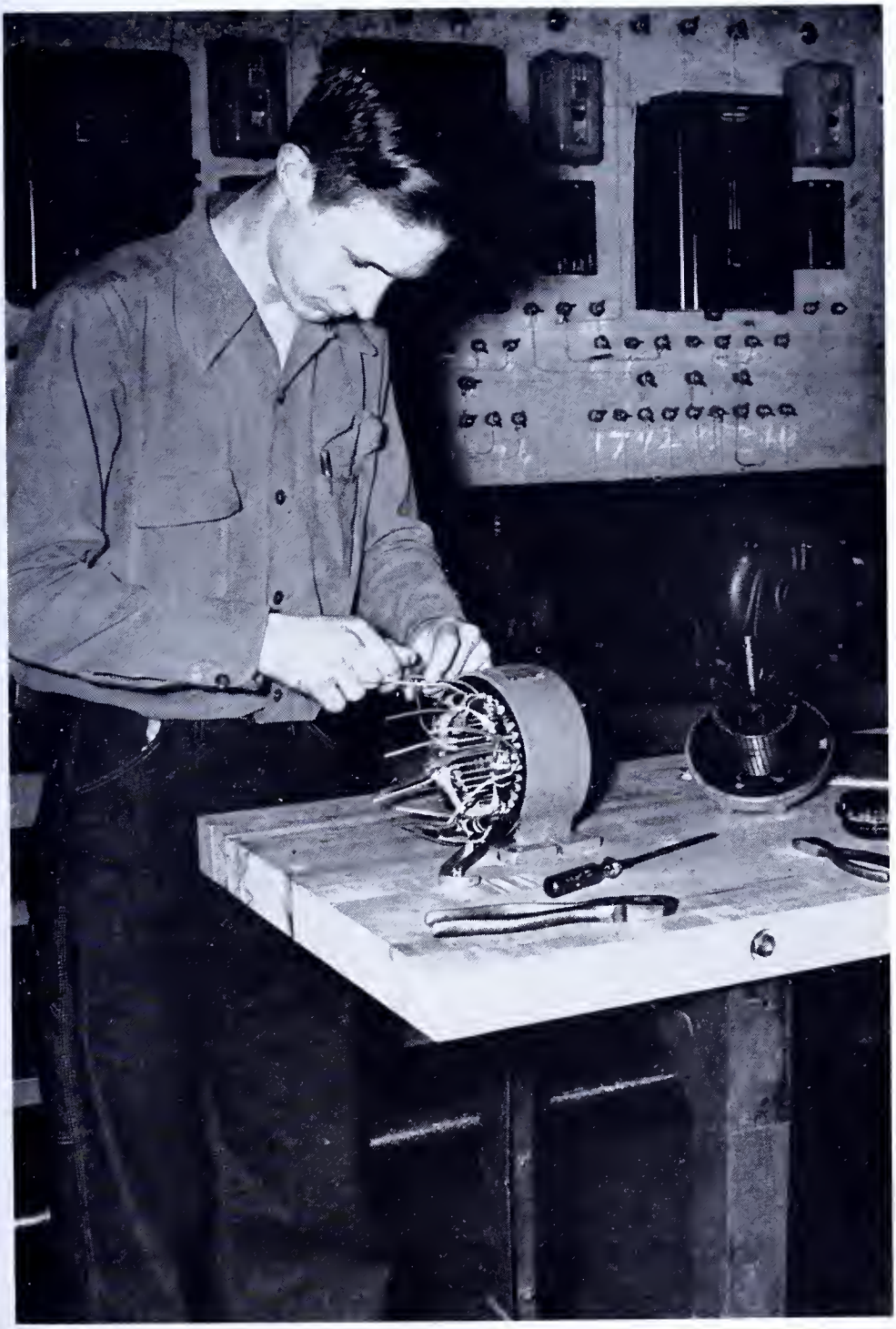
Story of the Storage Battery, The. Willard Storage Battery Company, Cleveland, Ohio, 16 mm., sound.

Summer Storm. Modern Talking Picture Service, 45 Rockefeller Plaza, New York 20, New York; 339 Boulevard of Allies, Pittsburgh 22, Pennsylvania. 16 mm. sound, 16 min. free, TCBW

What is Electricity. Modern Talking Picture Service, Inc., 45 Rockefeller Plaza, New York 20, N. Y.; 339 Boulevard of Allies, Pittsburgh 22, Pa., 16 mm. sound, 20 min. free, TCBW.

Years of Progress. Modern Talking Picture Service, 45 Rockefeller Plaza, New York 20, New York; 339 Boulevard of Allies, Pittsburgh 22, Pennsylvania. 16 mm. sound, 32 min. free, TCBW.

Your Wiring Check List. U. S. Department of Agriculture, Washington 25, D. C.



BULLETINS, CHARTS, AND POSTERS

A Course in the Elements of Modern Surface Raceway Wiring. Wiremold Co., Hartford 10, Conn.

Adventures in Electricity. The Maqua Co., Schenectady, N. Y.

Alternating Current Simply Explained. Wagner Electric Corp., 6400 Plymouth Ave., St. Louis 14, Mo.

Artificial Respiration. National Safety Council, 425 N. Michigan Ave., Chicago 11, Ill.

Battery Service Manual. Willard Storage Battery Co., 246 E. 131st St., Cleveland, O.

Clock Catalog. General Electric Co., 1285 Boston Ave., Bridgeport 2, Conn.

Corrosion in Soldering. Kester Solder Co., 4201 Wrightwood Ave., Chicago, Ill.

Electric Home Appliances. Teacher's Handbook. Westinghouse Electric Corp., Pittsburgh 30, Pa.

Electric Housewares. General Electric Co., 1285 Boston Ave., Bridgeport 2, Conn.

Electricity and Wheels. General Motors Educational Service, Department of Public Relations, Detroit 2, Mich.

Electronics Laboratory Manual. Westinghouse Electric Corp., Pittsburgh 30, Pa.

Expert Soldering. Stanley Tools, New Britain, Conn.

Facts on Soldering. Kester Solder Co., 4201 Wrightwood Ave., Chicago, Ill.

Farmstead Wiring Design Handbook. Illuminating Engineering Society, 1860 Broadway, New York 23, N. Y.

Handbook of Residential Wiring Design. Illuminating Engineering Society, 1860 Broadway, New York 23, N. Y.

Home (Home Wiring). General Electric Consumers' Institute, 1285 Boston Ave., Bridgeport, Conn.

Home Lighting, Recommended Practices. Illuminating Engineering Society, 1860 Broadway, New York 23, N. Y.

How to Build an Electric Motor. Westinghouse Electric Corp., Pittsburgh 30, Pa.

How to Choose and Use an Electric Cleaner. Hoover Co., N. Canton, O.

Industrial Safety Education in the Schools. Metropolitan Life Insurance Co., 1 Madison Ave., New York 10, N. Y.

Lessons in Practical Home Illumination (An outline). Illuminating Engineering Society, 1860 Broadway, New York 23, N. Y.

Magic of Communication, The. American Telephone and Telegraph Co., 195 Broadway, New York 7, N. Y.

National Electric Code as Recommended by the National Fire Protection Assn. National Board of Fire Underwriters, 85 John St., New York 38, N. Y.

Nature's Artillery (Lightning protection). National Board of Fire Underwriters, 85 John St., New York 38, N. Y.

New Way to Wire a House, The. National Electric Products Corp., Pittsburgh, Pa.

Pipe Threading Principles, Bulletin 6. National Tube Co., Pittsburgh, Pa.

Private Life of Your Home, The. National Adequate Wiring Bureau, 155 E. 44th St., New York 17, N. Y.

RCA Receiving Tubes. Allied Radio Corp., 833 W. Jackson Blvd., Chicago 7, Ill.

Residence Wiring Design Handbook. Illuminating Engineering Society, 1860 Broadway, New York 23, N. Y.

School Shop Safety. National Safety Council, 425 N. Michigan Ave., Chicago, Ill.

Soldering Tips. Kester Solder Co., 4201 Wrightwood Ave., Chicago, Ill.

Steel Electric Raceways. American Iron and Steel Institute, 350 Fifth Ave., New York 1, N. Y.

Storage Battery, The. Electric Storage Battery Co., Philadelphia, Pa.

Story Behind Underwriter's Laboratories, Inc., The. 207 E. Ohio St., Chicago 11, Ill.

Training Chart Manual. A–Fundamentals of Electricity and Magnetism, B–Storage Batteries, C–Cranking Motors and Series-Parallel Switches, D–Ignition System, E–Generators, F–Regulators. Delco-Remy Division, General Motors Corp., Anderson, Ind.

Use and Care Handbook for Portable Electric Tools. Black & Decker Manufacturing Co., Towson 4, Md.

Wiremold Surface Metal Raceway Wiring Systems. Wiremold Co., Hartford 10, Conn.

Your Guide to the Safe Installation of TV Receivers (I-39). Association of Casualty and Surety Companies, Accident Prevention Dept., 60 John St., New York 38, N. Y.

Your Guide to Safety When Disposing of Fluorescent and Mercury Vapor Lamps (I-31). Association of Casualty and Surety Companies, Accident Prevention Dept., 60 John St., New York 38, N. Y.

MAGAZINES[1]

ABC of Electronics at Work. Westinghouse Electric Corporation, Pittsburgh 30, Pa.

Boys' Life. Boy Scouts of America, 2 Park Ave., New York 16, N. Y.

CQ, The Radio Amateur's Journal. Radio Magazine, 342 Madison Ave., New York 17, N. Y.

Home Craftsman. 115 Worth Street, New York 13, N. Y.

Industrial Arts and Vocational Education.[2] Bruce Publishing Co., 400 N. Broadway, Milwaukee 1, Wis.

Popular Homecraft. General Publishing Co., 814 Tower Court, Chicago 11, Ill.

Popular Mechanics. 200 E. Ontario St., Chicago 11, Ill.

Popular Science. 353 Fourth Ave., New York 10, New York

QST (Amateur Radio). American Radio Relay League, 38 LaSalle Rd., West Hartford, Conn.

Science and Mechanics. 49 E. Superior St., Chicago 11, Ill.

School Shop.[2] 330 S. State St., Ann Arbor, Mich.

[1] Issued monthly unless otherwise indicated
[2] Ten issues a year

5 Equipment and Supplies

How to Select Equipment

THE INDUSTRIAL ARTS TEACHER in Pennsylvania is frequently the one person to whom the board of school directors and supervising principal or superintendent of schools must look for technical advice in the selection and ordering of shop tools and equipment. One measure of the success and stature of the Industrial Arts teacher is the astuteness with which he accomplishes this duty. Recommending new equipment to replace obsolete or worn-out equipment and the ordering of hand tools and consumable supplies, require forethought and sound judgment, if the teacher is to win and retain the respect of his superiors. No two schools have the same budget, physical plant, or educational program; therefore, all planning of tools, equipment, and supply needs must be made to fit local needs and resources.

A few guiding principles to be followed in selecting equipment and supplies may be summarized briefly as follows:

Item	*Quantity*	*Unit*	*Catalog No.*	*Name and Description of Item*	*Unit Cost*	*Total Cost*
1	1	each	5K225E10	Three-horsepower squirrel cage induction motor, general purpose, open, 40° C rise, horizontal with normal starting torque for three-phase, 220/440-volt, 60-cycle operation at 1800 r.p.m., with ball bearings.		
2	500	ft.		#14 solid AWG Type "R" SCRC *white* electric wire (Code wire).		
3	500	ft.		#14 solid AWG Type "R" SCRC *black* electric wire (Code wire).		
4	5	lb.		Round magnet-wire, No. 26 B & S gauge, enamelled and single cotton-covered, nonreturnable spool.		
5	18	each	1006	Stanley screwdrivers, 6″ blade with "Stanloid" handles.		
6				Flush toggle switches, Bakelite, brown base, 125-volt 10T.		
	20	each	6444	Single-pole.		
	10	each	6445	Double-pole.		
	20	each	6446	Three-way.		
	4	each	6447	Four-Way (125 volt 5T).		
	4	each	8624	3-circuit electrolier.		
	4	each	8625	2-circuit electrolier.		

1. The item of equipment should contribute directly to accomplishing one or more objectives of the course.

2. It should be suitable in size, power, and complexity of operation for the age group using it, *i.e.* junior high school, senior high school, or adult.

3. It should be selected with due care for the range of activities for which it may be used; for example, will a machine be required to accept special attachments?

4. The equipment should be compatible with the space available and should be within a suitable price range.

5. The equipment, tools, and supplies should be selected for a specific class size. They may be modified if a change in class size becomes mandatory.

6. The equipment should be modern in design and have all necessary safeguards. The switches and other operating controls must be placed where they cannot be actuated accidentally.

7. The equipment selected must conform to the utilities available; *i.e.,* proper electrical phase and voltage or suitable fuel whether oil, natural gas, or bottled gas.

8. The load-carrying capacity of the floor system must be considered when adding additional equipment or when relocating existing equipment.

How to Specify and Order Equipment and Supplies

Having determined the exact kind of tools and equipment which he needs to carry out his educational program and having selected the specific size, capacity, and type of each item, the teacher is faced with the problem of ordering these in such a way that he will receive exactly what he has spent so much thought in selecting.

Shop instructors should request on school stationery manufacturers' and distributors' catalogs covering the items under consideration. Complete descriptions, specifications, and numbers may be secured from these catalogs to help define the item you need. These items will usually fall into one of the following classifications and should be ordered accordingly.

Class I—Items which are well standardized and vary only in size, such as:

#26 ESC round copper magnet wire, or ½″ type A rectangular-threaded Cadmium-finish condulets.

SAMPLE INVENTORY FORM

FOR EQUIPMENT OR SUPPLIES–ELECTRICAL AREA

Item Description	On Hand Sept. 1	Quantity Expended	Unit Cost	Charged Off	On Hand June 30	Order	Unit Cost	Budget	Capital Investment
Pliers, electrician's, 5", wire cutting	5	1	1.88	1.88	4	1	1.88	1.88	9.40
Ammeter, range 0–40 amps.	1		2.06		1				2.06
Screws, 1½ #8, RH Bl., wood	4 gr.	2½ gr.	.98	2.45	1½ gr.	2 gr.	1.02	2.04	*
Be specific	Old and new items Check at beginning of year	Enter at end of school year	Enter from actual billing	Enter at end of school year	Inventory at end of school year	Enter prior to order date	Best estimate	Best estimate	Enter from actual billing Old and new items

*Because supplies are not capital investment, this space is blank when form is used for supplies.

These may be grouped and ordered by description only as there should be no confusion concerning what is actually wanted.

Class II—Items which are bought for performance characteristics such as electrical motors and meters. The specifications for these items should be carefully drawn to insure that they will do the job for which they are being ordered. (See item 1, page 64.) These specifications may be built around a specific piece of equipment which is acceptable but they must be general enough to permit a wide range of bidding.

Class III—Items which are bought because of special features of construction or educational application. Electrical distribution panels with different types of overload protection may be desired to demonstrate various ways and means of securing equal performance. It may be desired to demonstrate the internal connections of an induction motor by means of a 72-terminal, externally wired, interconnection board. Items such as these should be ordered by specific manufacturers' catalog number.

Class IV—Items which are bought for replacements or repairs and those new attachments needed for existing equipment. If open tool boards are used it is desirable that the replacement tools be the same as those now on the panel. In like manner a repair part for a machine must be one special piece. Therefore, all items in this class must be ordered by specific catalog and manufacturers' number.

(The bid requests for items in classes III and IV must include instructions that substitutes for these items cannot be accepted.)

Each item on the bid or order sheet must list all pertinent information to secure accurate and speedy filling of requests. Items should be listed uniformly and should be grouped by category. It is preferable to list supplies and equipment items on separate lists.

How to Keep an Inventory

Many different methods of keeping an inventory are used in Industrial Arts shops. The number and type of forms used to record inventory data depend largely on local school district practices. The important factor is that the industrial arts teacher is responsible to his superior for a periodic, accurate accounting of all shop tools, materials, and equipment. It is also his responsibility that the tools and equipment be maintained in good operating condition. The

advantages of taking and recording a periodic inventory are many, including:

1. A regular check on the condition and quantity of tools and materials.

2. Accurate information as to quantities consumed during the term.

3. Establishment of a sound basis for placing yearly requisitions.

4. A basis for retaining or redesigning certain projects to utilize cheaper or more available materials.

A comprehensive shop inventory form (p. 66) is suggested for the teacher who may desire to keep records and prepare reports which are comparable to records kept by a business establishment. Industrial Arts pupils might assist the teacher in keeping this type of inventory. The exploratory and occupational values to be derived from shop inventory and accounting practices are properly identified with Industrial Arts objectives.

This suggested inventory has the following general characteristics:

1. The description of each item can be used indefinitely by clipping blank check sheets with other columns along one side for calculation purposes.

2. Descriptive lists for both equipment and supply items can be accounted for.

3. Comprehensive reports can be prepared for the administrator to show accurately: the capital invested, annual operating costs, budget estimate, and the relationship of the amount of money collected from pupils for projects to the amount expended for supplies. (This last item would be of value in determining increase or decrease in cost of projects.)

Tools, Equipment, and Supplies

The tools, equipment and supplies suggested in this section of the bulletin are designed to provide instruction for five students in basic general electricity and its more common home applications. It is presumed that Electricity will be taught as one of several activities in a comprehensive general shop at the junior and/or senior high school level. If instruction in the more specialized areas of electricity (radio, television, armature winding, motor repair, and industrial electronics) is contemplated, this list must be modified and extended.

A competent teacher in these fields can provide a complete list of materials needed for them. More than five students may be accommodated by proportionate increases in the quantities shown.

Any trade, brand, or manufacturer's name appearing in this list is not preferred or recommended over other manufacturers' products.

Prices in this list are catalog list prices as of July 1, 1953. Varying discounts may be expected for prompt payment, quantity purchases, and for educational use.

Many items of equipment may be obtained locally for the teaching of various phases of electricity. Such items as telephone receivers, transmitters, induction coils, condensers, and magneto ringers may be obtained from the local telephone company. The local electric light and power company may be able to furnish watt-hour meters and service entrance equipment.

To teach appliance repair, an assortment of household appliances such as toasters, fractional horsepower motors, mixers, lamps, and lamp fixtures should be secured locally. Automotive electrical equipment such as generators, starters, regulators, horns, relays, and batteries should be secured as needed.

TOOLS, EQUIPMENT, AND MACHINERY LIST

Quantity	*Item*	*Approximate Cost*
	Alarm, burglar, all-purpose contactor	
2	closed circuit	$2.00
2	open circuit	2.00
1	Annunciator, surface type, hand reset, 4-point	22.00
3	Awls, scratch, 3½" blade[1]	.45
	Bits	
1 set	auger, 4/16" to 16/16"[1]	11.18
1	expansion, No. 2, 7/8" to 3"[1]	2.16
	Blowtorch	
1	alcohol, automatic	3.75
1	gasoline, 1-qt. capacity	8.47
2	Braces, ratchet, 10" swing[1]	6.59
	Cable	
20 ft.	service entrance, two-conductor, No. 8	5.20
20 ft.	service entrance, three-conductor, No. 8	8.20
1	Charger, battery, selenium rectifier, cap. 3-cell, 115-volt, 60-cycle	21.50
1 set	Chisels, butt, set of 6, ¼" to 1½"[1]	14.53
1	Compass, magnetic, 25 mm., plastic case	1.50
1	Conduit bender (hickey)[2]	3.20

[1] Omit if available from another activity area of the shop.
[2] Order only if elementary rigid-conduit wiring is taught.

Quantity	*Item*	*Approximate Cost*
1	Direct current power supply, selenium rectifier type, 125-volt, 12-amp., D.C., complete with overload protection, wall mounting	390.00
1	Door opener, mortise type, electric	4.00
1	Dresser, grinding wheel, No. 0, hooded[1]	1.00
	Drills	
1 set	carbon twist, straight shank, 1/16" to 1/2" by 32nds, with stand[1]	7.02
1	hand, 3-jaw chuck, 1/4" cap.[1]	5.20
1	Drill press, 15" cap., with 0"-1/2" Jacobs chuck, complete with motor, switch, pulleys and belts[1]	173.50
1	Drop, constant-ringing, 8-12-volt A.C.	3.50
1	Furnace, gas, 2-burner with cast-iron top, No. 10[1]	10.64
1	Fuse puller, fibre, 7 1/2" long	.90
	Gauges	
1	drill and tap[1]	4.30
	wire, B&S, 0-36	4.50
1	Grinder, bench, 1/3-H.P., 1/2" spindle with 6" x 3/4" wheels, one coarse, one fine; two adjustable tool rests[1]	63.00
2	Hack saws, adjustable frames, pistol grips[1]	2.50
	Hammers	
1	ball peen, 12-oz.[1]	1.35
2	claw, 13-oz.[1]	4.60
1	Hydrometer, battery-testing	.85
1	Indicator, speed, hand	2.20
5	Knives, sloyd, 3 1/8" blades	3.05
	Magnets	
2	bar, 200 mm. x 20 mm., with keepers	1.65
2	U-shaped, 112 mm. long, 50 mm. between poles	2.50
	Meters	
1	ammeter, 0 to 2-amp., D.C.[2]	12.00
1	ammeter, 0 to 15-amp., D.C.[2]	12.00
1	ammeter, 0 to 3-amp., A.C.[2]	12.00
1	ammeter, 0 to 20-amp., A.C.[2]	12.00
1	voltmeter, 0 to 5-volt, D.C.[2]	12.25
1	voltmeter, 0 to 150-volt, D.C.[2]	12.25
1	voltmeter, 0 to 5-volt, A.C.[2]	12.00
1	voltmeter, 0 to 150-volt, A.C.[2]	12.00
1	volt-ohm-milliammeter, 100 ohms per volt, 2% accuracy, pocket-size, with case	29.90
1	watch case battery volt-ammeter, 0-40 amp.	2 .06
1	watt-hour, with socket, universal 2-wire/3-wire, 15 amp., single-phase, 60-cycle	20.38
1	Oiler, bench, 1/3-pt., straight nozzle[1]	.60

[1] Omit if available from another activity area of the shop.

[2] Voltmeters and ammeters should have accuracy of 2% full-scale and be 3 1/2" diameter flush-mounted panel instruments.

Quantity	*Item*	*Approximate Cost*
1	Pipe cutter, No. 2 Saunders type [1, 2]	$7.85
1 set	Pipe stock and dies, Armstrong type, 1/8" to 1" [1, 2]	16.32
	Pliers	
5	combination, 6", slip-joint	2.50
2	diagonal-cutting, 5"	2.33
1	needle-nose, 4", without cutters	1.97
1	round-nose, 4", without cutters	1.66
5	side-cutting, 6"	9.60
1	Punch, center, 5/16" x 4" [1]	.14
1	Reamer, burring, bit shank, 1/8" to 1" cap. [1, 2]	1.50
	Relays	
1	burglar alarm, open circuit, 8 to 12 volts, A.C.	10.00
1	burglar alarm, closed circuit, 8 to 12 volts, A.C.	10.00
1	midget, single-pole, single-break, front contact, 125-volt	3.75
1	midget, double-pole, single-break, front contact, 125-volt	4.75
1	midget, single-pole, single-break, back contact, 125-volt	3.75
1	midget, double-pole, single-break, back contact, 125-volt	4.75
1	Rule, zigzag, 6-ft., white enamel	1.38
	Screwdrivers	
1	No. 1 Phillips	.35
1	No. 2 Phillips	.39
1	No. 3 Phillips	.50
5	4", plastic handle, standard blade	4.20
2	6", plastic handle, standard blade	2.22
1	8", plastic handle, standard blade	1.38
1	10", plastic handle, standard blade	2.00
1	Screwplate, N.C. and N.F., 4-36 to 1/4-20 incl. taps, round dies, tap wrench, and die holder [1]	15.00
	Service Panels	
1	30-amp. cap., residence, 2-wire mains, 2-wire branches, 4-circuit	4.40
1	100-amp. cap., residence, 3-wire mains, 2-wire branches, 4-circuit plus range circuit	35.00
1	Snips, tin, 3" cut [1]	4.20
1 pair	Soldering coppers, 2-lb.	2.00
1	Soldering iron, electric, 1/2" tip, 80-watt	7.68
1	Tester, circuit, 80- to 500-volts	.50
	Transformers	
1	doorbell, 10-watt	2.50
1	neon sign, standard duty, 15,000 volt, 30 M.A. (Optional for insulation testing and high voltage demonstrations)	9.40

[1] Omit if available from another activity area of the shop.
[2] Order only if elementary rigid-conduit wiring is taught.

Quantity	*Item*	*Approximate Cost*
1	variable-voltage taps and rheostat, 1½-24 volts	25.00
1	Try square, 8″	1.20
	Vises	
2	machinist, 4″-wide jaws, 6″ opening	51.00
1	pipe, for ⅛″ to 1½″ pipe[2]	7.67
	Wrenches	
2	adjustable, 4″	1.00
1	adjustable, 8″	1.21
1	adjustable, 12″	2.26
1	pipe, 8″	1.50
1	pipe, 10″	1.96
	Total	$1,215.20

CONSUMABLE SUPPLY LIST

Quantity	*Item*	*Approximate Cost*
4 pts.	Alcohol torch fuel	$2.00
	Batteries	
6	dry cell, No. 6, 1½-volt	4.74
1	dry cell, cutaway for instructional purposes[1]	....
1	gravity cell, crowfoot type	3.50
1	storage, 100 amp.-hr.	23.95
1	storage, cell, cutaway for instructional purposes (secure sample)	....
	Battery clips	
12	25-amp.	1.80
12	5-amp.	1.20
3	Battery jars, 1-qt.	.85
1 gal.	Battery water, distilled	.50
	Blades	
12	hack saw, 18T-12", flexible back	1.56
12	hack saw, 32T-12", flexible back	1.56
	Boxes, outlet (galvanized or black enamel)	
8	4" octagon, nonmetallic-sheathed cable[3, 4]	2.48
8	4" octagonal, flexible metallic conduit[2, 3]	2.48
8	4" square, 1½" deep[3, 5]	3.04
8	2⅛"x4" utility, 1½" deep[3, 5]	3.84
	Boxes, switch, (galvanized or black enamel)	
8	for flexible metallic conduit[2, 3]	3.12
8	for nonmetallic-sheathed cable[3, 4]	3.60
8	for rigid metallic conduit[3, 5]	3.52
	Bulbs	
24	flashlight, for miniature sockets	2.50
12	25-watt, 120-volt	2.04
	Bushings	
6	Bakelite, ⅛" pipe thread for socket caps	.10
12	½" end for rigid conduit[5]	.60
50	fibre insulating for B.X.[2]	.30
12	Buzzers, door, double-coil	7.80
	Caps	
12	Bakelite, attachment plug	.62
1	entrance cable, aluminum, 2-wire	.49
1	entrance cable, aluminum, 3-wire	.49
2	Clamps, ground, for #6 bare wire	.90
100	Clips, Fahnstock, #15	.90
1	Cloth, wool, for static electricity	1.25
5	Conduit, rigid, ½" black enamel, 10' lengths[5]	5.00

[1] Should be made in shop.
[2] Order only if armored cable or flexible metallic cable wiring is taught.
[3] Omit if elementary residence wiring is not taught.
[4] Order only if elementary nonmetallic-sheathed cable wiring is taught.
[5] Order only if elementary rigid-conduit wiring is taught.

Quantity	*Item*	*Approximate Cost*
	Condulets, ½", cadmium finish, Obround series[1]	
2 ea.	types A and B	2.40
4 ea.	types C, LB, LR, and LL	12.32
	Connectors, box	
12	½" with lock nut for #14-2 armored cable[2]	1.52
12	½" with lock nut for #14-2 nonmetallic-sheathed cable[3]	1.64
6	½" 90° angle for #14-2 armored cable[2]	1.14
3	Connectors, cable to openwork, end bushings[2, 3]	1.83
6	Convenience outlets, duplex, brown[4]	1.14
	Covers, box outlet, galvanized or black enamel, for 4" octagon boxes[2, 3, 4]	
4	blank	.44
4	flat, snap switch	.60
	for 4" square boxes[1]	
4	blank	.48
6	raised rings for two rectangular-base switches or receptacles	1.50
4	raised rings for single rectangular-base switches or receptacles	1.00
4	square, for one toggle switch	1.00
4	square, for one toggle switch and one duplex convenience outlet	1.00
4	square, for two tumbler switches	1.00
	for utility boxes[1]	
4	duplex receptacle	.60
4	toggle switch	.60
	Covers, condulet[1]	
12	blank, sheetmetal	1.32
6	two-hole, composition	1.20
6	three-hole, composition	1.20
	Covers, outlet, Bakelite, brown, wall plate[1]	
4	duplex receptacle	.32
4	one toggle switch and one duplex outlet	.60
4	single toggle switch	.32
4	two-gang toggle switch	.60
12	Doorbells, covered, double-coil	8.40
	Files[5]	
2	auger bit, 7"	.88
2	flat, bastard, 12"	1.92
2	mill, smooth, 8"	1.06
6	File handles, #2[5]	.61

[1] Order only if elementary rigid-conduit wiring is taught.
[2] Order only if armored cable or flexible metallic cable wiring is taught.
[3] Order only if elementary nonmetallic-sheathed cable wiring is taught.
[4] Omit if elementary residence wiring is not taught.
[5] Omit if available from another activity area of the shop.

Quantity	*Item*	*Approximate Cost*
2	File cards and brushes[1]	1.98
1 lb.	Filings, iron[2]	
	Fittings	
2	entrance, single-screw type, nonwaterproof, ¾" for oval cable	.80
2	entrance, single-screw type, waterproof, ¾" for oval cable	.80
6	Fixture studs, 4-prong[3]	.60
3 lbs.	Flux, soldering, one-pound cans, noncorrosive	2.10
1	Fur, cat's	3.00
	Fuse cutouts	
5	enclosed, cartridge, 600-volt, 30-amp, main line, double-pole	9.00
5	plug, 125-150-volt, 30-amp. main line, double-pole	8.70
	Fuse links	
50	renewal, 25-amp., cartridge	1.25
50	renewal, 15-amp., plug	1.00
50	renewal, 5-amp., plug	1.00
12	Fuses, plug, renewable, 15-amp.	6.00
6	Fuses, cartridge, renewable, 25-amp.	2.75
	Heater elements	
2	flatiron, 125-volt	1.20
6	radiant heater, medium screw-base	4.14
2	toaster, 125-volt	2.00
	Iron rod	
3 ft.	hard, 5/16" round	.50
3 ft.	soft, 5/16" round	.50
50	Locknuts, ½" galv.[3]	1.17
	Nails[1]	
5 lbs.	1" blue roofing	.80
5 lbs.	4d common	.80
5 lbs.	8d common	.80
10 ft.	Pipe, continuous thread, ⅛"	4.00
	Push buttons	
12	brass case, single-contact	2.00
3	brass case, double-contact	3.00
	Receptacles	
12	porcelain, cleat, medium base	1.30
25	porcelain cleat, miniature base	1.15
	Rods	
2	glass, 13 cm. x 30 cm.	1.08
2	hard-rubber, 13 cm. x 30 cm.	1.20

[1] Omit if available from another activity area of the shop
[2] Should be made in the shop.
[3] Omit if elementary residence wiring is not taught.

Quantity	*Item*	*Approximate Cost*
	Screws, machine[1]	
1 gr.	6-32 x ½" flat-head, bright	.41
1 gr.	6-32 x ¾" flat-head, bright	.47
1 gr.	8-32 x 1" flat-head, bright	.68
1 gr.	6-32 x 1" round-head, bright	.54
1 gr.	8-32 x 1" round-head, bright	.68
1 gr.	10-24 x 1" round-head, bright	.76
1 gr.	10-32 x 1" round-head, bright	.76
	Screws, wood[1]	
1 gr.	6 x ¾" flat-head, bright	.56
1 gr.	8 x 1" round-head, blued	.81
1 gr.	8 x 1½" round-head, blued	.98
1 gr.	8 x 2½" round-head, blued	1.44
6	Sleeves, ½" conduit, black enamel[2]	.66
6	Sockets, brass shell, ⅛" pipe-thread cap, with key switch	2.91
5 lbs.	Solder, wire, 50/50, 1-lb. spools	7.30
12	Soldering lugs, 25-amp.	.60
6	Solderless terminal lugs, #14 wire, 15-amp.	.30
6	Solderless branch taps, #14 wire, 15-amp.	.90
6	Solderless connectors ("wire-nuts") for #14 wire	.18
25	Splicing sleeves, single-tube	1.50
500	Staples, insulated	1.15
	Straps	
5 lbs.	2-hole, pipe[2]	1.45
5 lbs.	1-hole, pipe[2, 3]	1.75
5 lbs.	1-hole, for nonmetallic-sheathed cable[4]	1.50
20	Subbases, porcelain	4.00
	Switches	
10	flush toggle, brown Bakelite base, 125-volt 10T	5.00
5	double-pole	5.50
4	four-way, 125-volt, 5T	7.20
10	single-pole	5.00
10	three-way	6.30
	knife, battery, 15-amp.	
5	double-pole, double-throw	3.55
5	double-pole, single-throw	2.50
10	single-pole, double-throw	3.70
10	single-pole, single-throw	3.00
1	triple-pole, double-throw	3.20
2	triple-pole, single-throw	5.10
	rotary snap, surface, slotted base, porcelain	
5	double-pole	5.00
4	four-way	16.00

[1] Omit if available from another activity area of the shop.
[2] Order only if elementary rigid-conduit wiring is taught.
[3] Order only if armored cable or flexible metallic cable wiring is taught.
[4] Order only if elementary nonmetallic-sheathed cable wiring is taught.

Quantity	*Item*	*Approximate Cost*
	Switches (Continued)	
5	electrolier, 3-circuit, 1, 1 and 2, 1, 2 and 3, off	8.75
10	single-pole	5.00
10	three-way	7.50
	Tape	
6	friction, 1-lb. rolls	3.15
6	rubber, 1-lb. rolls	3.55
	Wire	
10 rolls	annunciator wire, #18, 1-lb. rolls	15.00
150 ft.	armored cable, (BX), #14-2[1]	15.38
100 ft.	armored cable, (BX), #14-3[1]	13.85
500 ft.	code, #14, solid, Type R, SBRC, black[2]	8.35
500 ft.	code, #14, solid, Type R, SBRC, white[2]	8.35
20 ft.	copper, #6, bare	1.20
150 ft.	cord, green, twisted lamp, #18	3.75
100 ft.	cord, rip, twin-conductor type, POSJ #18	3.42
100 ft.	cord, rubber-jacketed, twin conductor type, S #16	9.30
100 ft.	fixture and appliance type, TFF 32, #18	2.10
5 lbs.	Nichrome resistance, #19	16.65
5 lbs.	Nichrome resistance, #22	22.25
3 lbs.	Nichrome resistance, #26	18.15
150 ft.	nonmetallic-sheathed cable, #14-2[1]	9.75
100 ft.	nonmetallic-sheathed cable, #14-3[1]	12.00
	round magnet, plastic-covered	
5 lbs.	#16	5.30
5 lbs.	#18	5.70
3 lbs.	#20	3.63
3 lbs.	#22	3.75
3 lbs.	#24	4.05
3 lbs.	#26	5.41
	Total	$518.62

[1] Order only if armored cable or flexible metallic cable wiring is taught.
[2] Omit if elementary residence wiring is not taught.

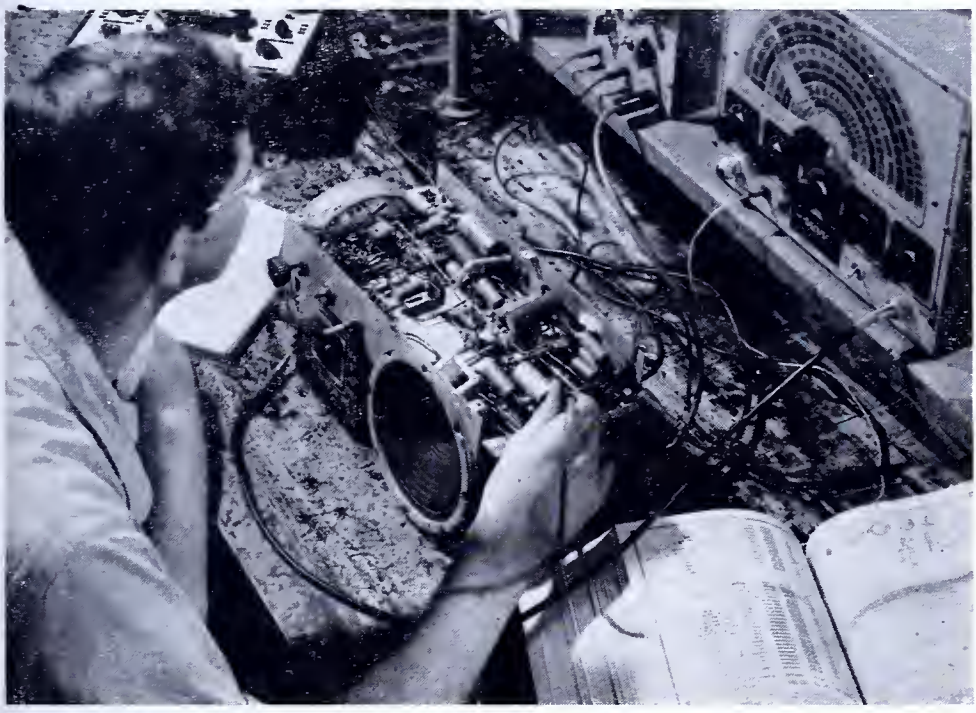
Storage and Control of Tools, Supplies, and Projects

The storage and control of tools in any shop depend largely on the physical layout of the shop, the number and types of activities, size of class, money available, and the ease with which the tools can be checked at the end of the shop period.

Present trends are away from the traditional tool room in favor of the open tool panel, which may be fixed or portable, and which should contain the hand tools normally used in a work area. The panels are built so that they may be locked when the shop is unoccupied. A silhouette of each tool may be painted or fastened to the panel to facilitate the replacing of tools by the pupils and the checking of tools by the teacher. Further suggestions on tool control can be found in *Industrial Arts in Pennsylvania,* Bulletin 331, Department of Public Instruction, pages 91-93.

Providing storage space for consumable supplies is an important factor in planning facilities for Industrial Arts education. Supplies for the Electricity Area are likely to be small and of great variety. Numerous small bins in a cabinet or cupboard are very practicable. Bins or shelves should also be provided for the storage of electrical projects. Such storage should be dry and well lighted. Racks may be provided for reels of wire and cable and for lengths of conduit and surface raceways which normally come in ten-foot lengths.

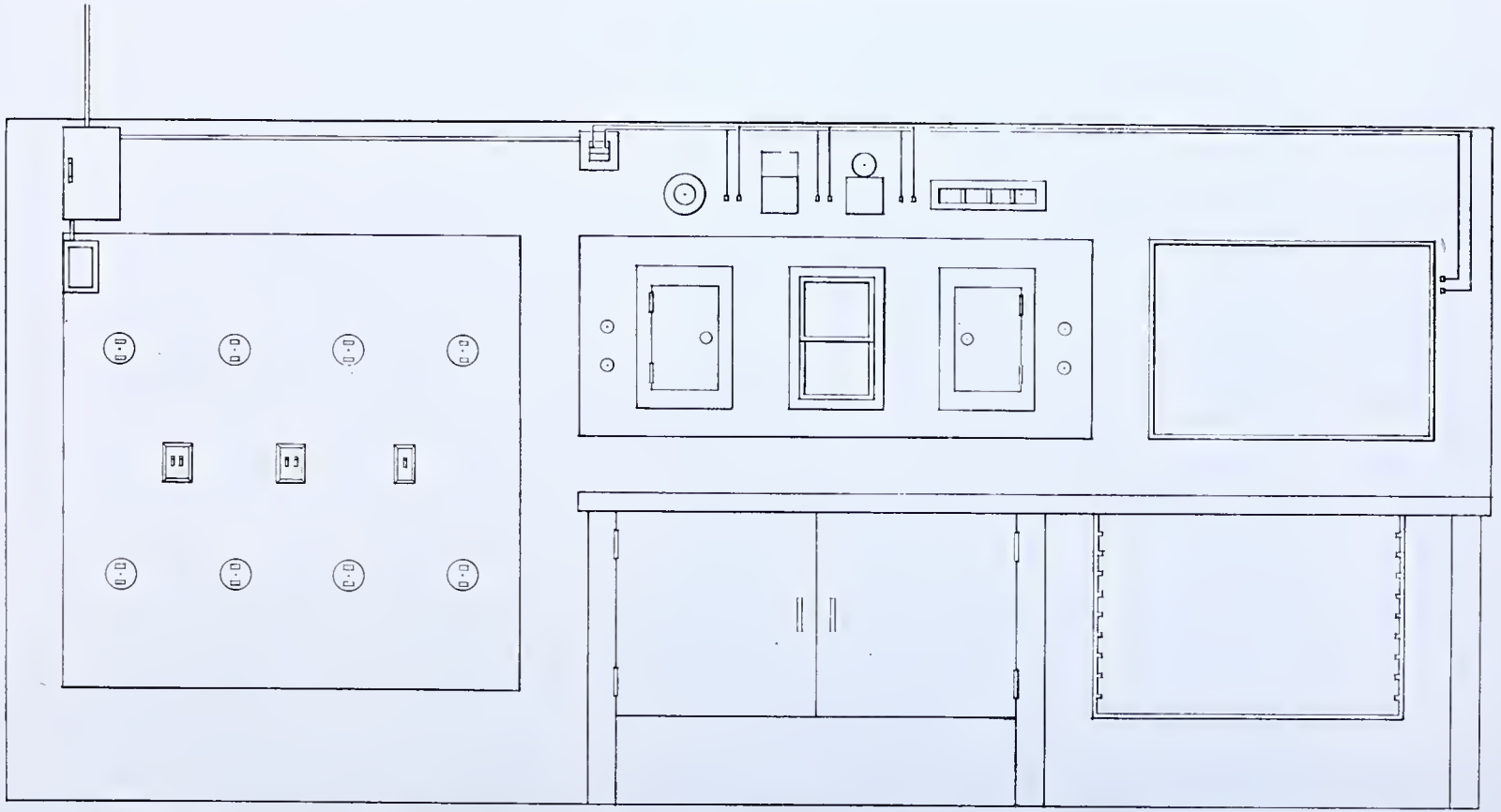
6 Suggested Electricity Activities Center



THE ELECTRICITY ACTIVITIES CENTER pictured on pages 80 to 82 will provide a flexible, multi-activity area suitable for use in a comprehensive general shop. The unit can be readily fitted into the floor plans and equipment arrangements developed to accommodate any combination of the twelve Industrial Arts subject areas suggested in this series of supplementary bulletins.

The unit provides equipment to enable the pupil to learn all the projects necessary in fundamental circuit wiring for bells, buzzers, burglar alarms, electric door locks, annunciators, convenience outlets, switches, and lights. The wiring of branch circuits and service entrances, along with testing and replacing of lights, switches, and outlets, can also be taught on this device.

Provision is made for individual pupil work on wiring boards to learn elementary circuits. The boards and supplies may be stored in



Front elevation plan for Electricity Activities Center. See side elevation on page 81. See page 82 for perspective drawing.

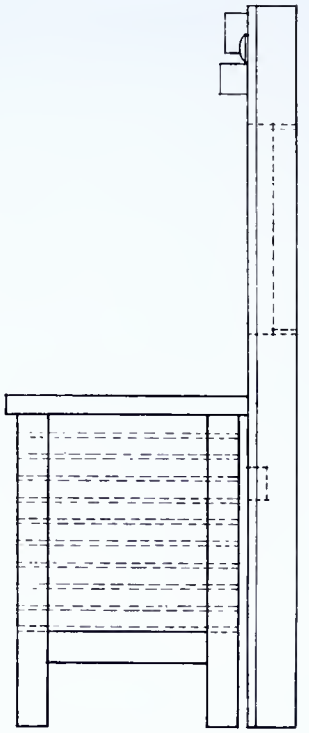
the base of the unit. If it is desirable to teach testing and repairing of electrical equipment, a bench should be added to the Electricity Activities Center.

The frame of the Electricity Activities Center is 6′ high and 12′ long, constructed of 2″ x 4″ lumber, and faced with ¾″ plywood. A standard metal table, 33″ high, with a maple top 8′ x 2′, is placed against the right end of the frame.

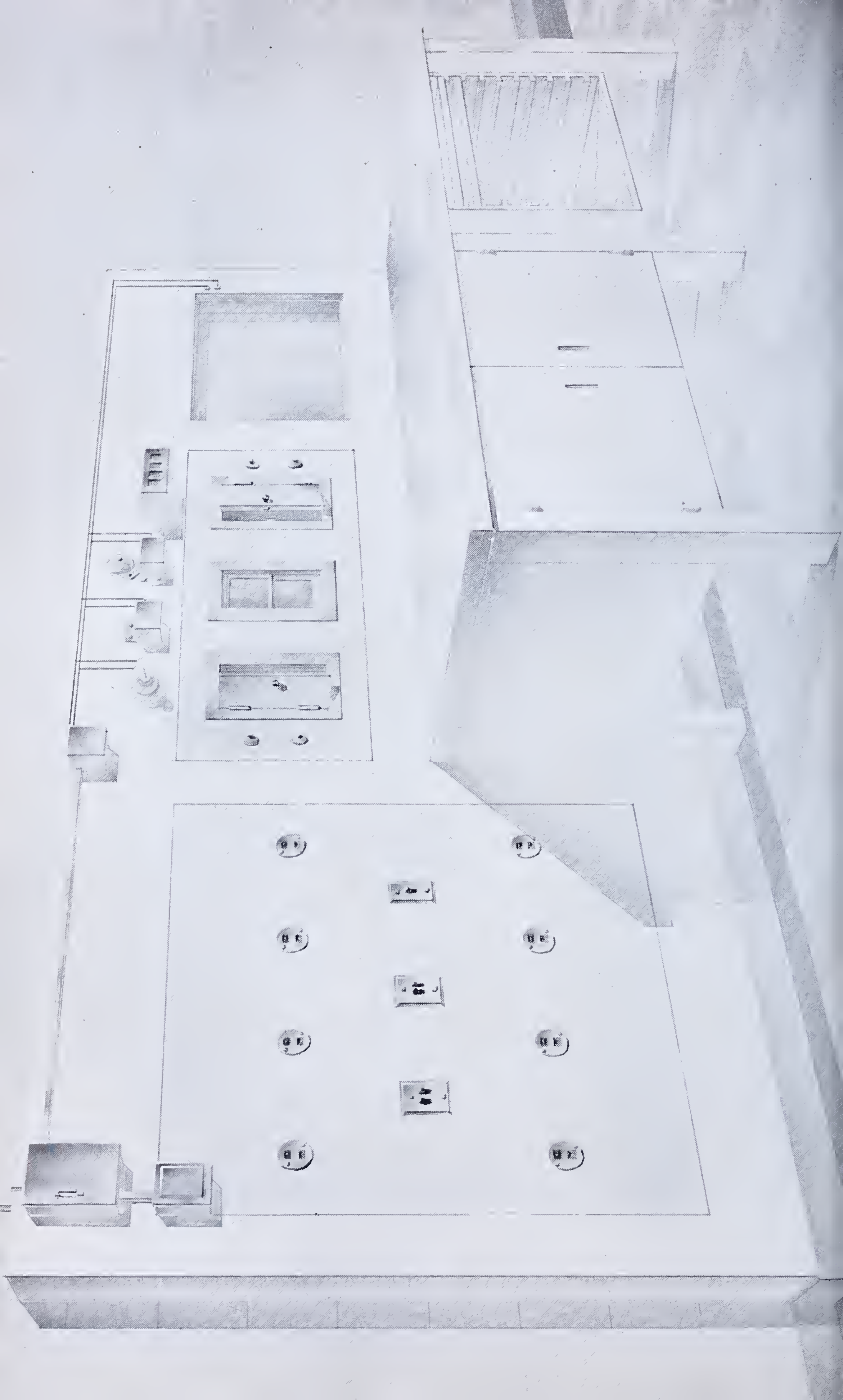
The opening on the right above the table is recessed to accommodate 21″ x 30″ wiring boards. Latches should be provided to hold them firmly in place while being tested on the source of low-voltage electricity shown.

The center panel is 4′-6″ long by 21″ high. The over-all dimensions of the miniature doors and windows are 10″ in width and 15″ in height. Two push buttons are shown beside each door. Not visible but suitably installed are electric door locks, burglar alarm contacts (open and closed circuits), and closet switches. Removable panels are shown to provide access for wiring to the appropriate buzzer, bell, chime, light, or annunciator mounted above. Wiring jobs ranging from automatically operated closet lights, through apartment house bell and door-opener circuits, front and back door chime or bell circuits, to a simple circuit of one button ringing one bell may be taught.

At the left end and accessible from the floor is a 4′ 0″ x 4′ 0″ panel containing single- and two-gang switch installations along with a number of outlet boxes in which any desired combinations of outlets and lamp holders may be installed. This panel may be made removable so that various approved wiring systems may be installed in the frame behind it, and then connected to the outlets and switches, or, it may be fastened with a permanent wiring system installed behind it and connected to the switches and outlets for testing, replacement, and repair jobs only.



Side elevation plan for Electricity Activities Center.



The whole panel is fed from a standard four-circuit service entrance distribution box, which may be mounted in connection with a standard meter socket if desired. One circuit is used to energize a low-voltage transformer which supplies electricity to the various low-voltage devices and for testing the wiring board circuits. Another circuit is used to supply electricity to a separate switch box used to connect and disconnect the house wiring panel.

Other supplementary bulletins in this series feature room plans showing electricity areas as a part of comprehensive general shops.

◀◀◀◀ Perspective plan of Electricity Activities Center

NOTES